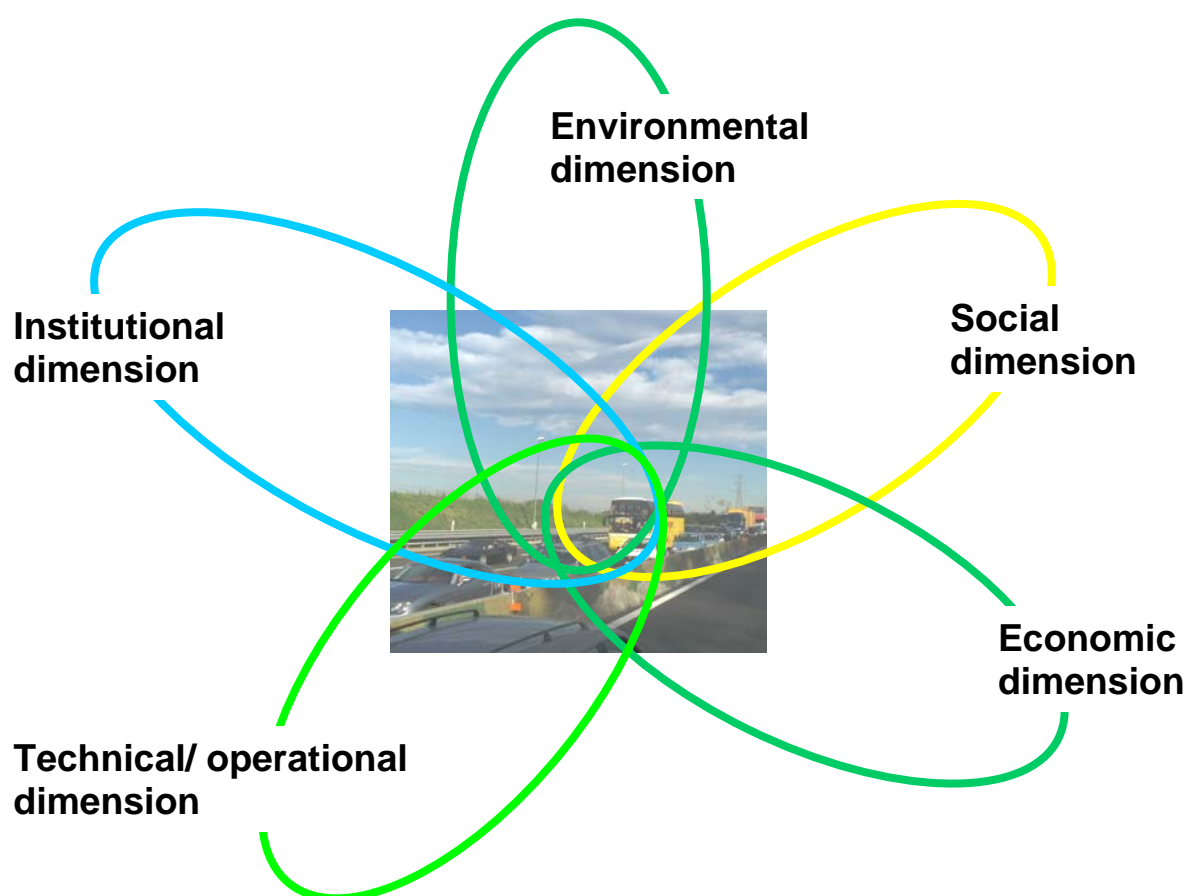


# Indicators to Assess Sustainability of Transport Activities

Part 2: Measurement and Evaluation of Transport Sustainability Performance in the EU27

A. Dobranskyte-Niskota, A. Perujo, J. Jesinghaus and P. Jensen



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## Executive Summary

Inspired by the growing interest of academic and policy environments in the field of transport sustainability, this work focuses on the measurement and assessment of transport activities in the European Union (EU) with the use of transport sustainability indicators. In particular, this study aims at quantitatively estimating sustainability performance of transport activities of the individual EU Member States.

On the basis of major international transport related indicator initiatives a set of 55 transport sustainability indicators has been developed (as defined in detail in the first part of this report series by Dobranskyte-Niskota *et al.*, 2007). The current report only briefly presents and summarises the structure of the newly developed transport sustainability indicator framework which is, then, subsequently integrated into further analytical steps of quantitative sustainability performance assessment of transport activities. These steps include 1) application of the “Dashboard of Sustainability” graphic interface tool and various methodological techniques for the development of aggregate *SusTrans Index* and the *EEA TERM Index*, 2) ranking and evaluation of transport sustainability performance in the EU27 Member States according to the *SusTrans Index* and 3) benchmarking transport sustainability performance of the EU 27 with the help of the *EEA TERM Index*.

The current report centres on the quantification process of the selected transport indicators by utilising the data from various major international databases related to transport as well as on measurement and assessment of transport sustainability performance in the EU 27. Due to the lack of data, out of 55 originally proposed indicators only 32 indicators could be analysed in quantitative terms. Although data availability is one of the criteria used in defining a set of indicators, data reliability and completeness are also essential factors. Thus, we have tried to obtain the maximum available number of quantitative indicators which had the most complete amount of data for the individual EU Member States. The European Commission DG- Joint Research Centre software tool the “Dashboard of Sustainability” has been applied to this transport indicator set. This graphic interface is designed to compare indicator groups, to communicate a quick impression and point to areas where indicators show particular success or problems. Thus, it permits to quantitatively assess sustainability performance of the EU transport activities along the economic, social and environmental, technical/operational and institutional sustainability dimensions. In addition, an aggregate transport sustainability index, which we have titled the *SusTrans Index*, has been calculated on the basis of the transport sustainability indicator set using the Equal Weight Aggregation (EWA) method. The results obtained are presented and the overall findings of the transport sustainability performance in the EU 27 are discussed. The study also analyses the trends of transport sustainability performance over the period from 2000 to 2005, indicating that economic and environmental sustainability dimensions of transport activities are the most urgent priority action areas.

Eventually the “Dashboard of Sustainability” tool has been also applied to the Transport and Environment Reporting Mechanism (TERM) indicator set developed by the European Environmental Agency (EEA) and consequently the *EEA TERM Index* has been calculated. This allowed for benchmarking the results obtained from the quantitative analysis of the *SusTrans* transport indicator set by comparing them directly to the *EEA TERM* indicators. Ranking obtained by both the *JRC SusTrans* and the *EEA TERM* indices suggest that Germany, Belgium, Netherlands are among the best performing EU Member States in terms of transport sustainability. According to both indices the lowest transport sustainability performance is observed in the Eastern EU Member States, among which are Greece as well as Estonia, Bulgaria and Lithuania. Analysis of EU 27 transport activities by the selected sustainability indicators using adequate methodological tools serves as valuable guidelines for forming transport sustainability policy strategies. The overall aim is to reduce negative impacts of transport activities and achieve sustainable transportation system in the European Union.

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## **Abbreviations**

CAFE	Clean Air For Europe Programme
EC	European Commission
EEA	European Environment Agency
ETIS	European Transport policy Information System
EU	European Union
EUROSTAT	Statistical Office of the European Communities
IIASA	International Institute for Applied Systems Analysis
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
ITF	International Transport Forum
JRC	European Commission, DG-Joint Research Centre
OECD	Organization for Economic Cooperation and Development
RAINS	Regional Air Pollution and Information System
SUSTRANS	Sustainable Transport Index
TERM	Transport and Environment Reporting Mechanism
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environmental Protection Agency
VTPI	Victoria Transport Policy Institute
WHO	World Health Organization
WCED	World Commission on Environment and Development

# 1 INTRODUCTION

## 1.1 Background

Transport plays a fundamental role in economy, as its demand is closely linked to economic growth. However, at the same time transport triggers the growth of negative impacts on human health and the environment which asks for urgent responses from policy- and decision-makers making it a priority action area. In the recent European transport policy related documents (EC, 2006; EC, 2009) the major objective of the EU sustainable transport system is to meet society's economic, social and environmental needs. This implies that effective transportation systems should positively contribute to economic growth, social development via an adequate use of natural resources and environmental protection. Transport sustainability policies also aim to find solutions to address negative externalities, which affect the environment (among others: pollution, CO<sub>2</sub> emissions and noise), the economy (for instance, congestion) and society (equity and accessibility, health, safety and security most importantly) (EC, 2009). The common Transport Policy White Paper "European transport policy for 2010: time to decide" (EC, 2001) identifies the main EU transport challenges such as measures of shifting the balance between modes of transport, eliminating bottlenecks, placing users at the heart of transport policy, managing the effects of transport globalisation and addressing the impacts on the environment. The recent EU Green Paper "Towards a new culture for urban mobility" (EC, 2007) additionally addresses sustainability of transportation systems in urban areas which are known to concentrate the vast majority of the population where air and noise pollution is getting worse year by year and the number of traffic victims is increasing. Therefore, aiming to combat or at least mitigate these complex negative impacts originating from transport activities, valid and widely-acceptable decision support tools need to be implemented.

The use of indicators to measure various aspects of sustainable development has been growing in the last couple of decades. Indicators are frequently defined as quantitative measures used "to illustrate and communicate complex phenomena simply, including trends and progress over time" (EEA, 2005). They are increasingly considered to be useful tools in the measurement and evaluation of transport sustainability performance towards established goals and objectives. Quantitative evaluation of transport activities in the major European transport indicator sets is carried out by the initiatives of the European Commission (EC) and its specialised agencies (Eurostat and European Environment Agency). Additional initiatives, regarding the impacts of transport activities on human health and safety are jointly addressed by the EC and World Health Organisation (WHO). Apart from dealing with a great variety of transport related interdisciplinary aspects, the above mentioned European transport indicator initiatives tend to reflect specific policy aims/ focus of each individual organisation. For example, the environmental dimension of sustainability is strongly emphasised in the transport indicator initiatives of the EEA, while the WHO addresses social aspects of sustainability focusing mainly on health and safety issues. Indicator initiatives of the EC and the Eurostat reflect the major transport policy priorities of the EU. From these practices and as well as from the literature it becomes clear that quantification of transport related indicators poses a challenge, which depends on such factors as data availability and comparability. In some cases, certain aspects (for instance, environmental assets and social patterns) are difficult to estimate in monetary and other quantitative terms (Perman *et al.*, 1999).

The current report is the continuation of the first part report series which was focused on the review of the existing transport sustainability indicators initiatives and the development of our own indicator set to assess transport sustainability performance. The indicator set that we have developed on the basis of selected transport related indicator initiatives combines several interdisciplinary aspects, which have been grouped into economic, social, environmental, technical/ operational and institutional sustainability dimensions. Although the Brundtland Commission (WCED, 1987) report defining the notion of sustainable development has clearly distinguished the three major sustainability pillars, namely economic, social and environmental, in our study we have included additional two

sustainability dimensions such as technical/ operational and institutional. Technology as well as operability are inseparable parts of transport activities, thus we felt the need to have this dimension separately distinguished. Institutional dimension may as well be part of social sustainability dimension. However taking into account that the importance and effectiveness of the institutional role in sustainability is often overlooked, in current study this dimension has been separately emphasised. Further in the text we will refer to these above mentioned sustainability dimensions as the five transport sustainability dimensions.

International data sources have been used to quantify indicators where available. Evaluation of transport sustainability performance along the above mentioned sustainability dimensions is carried out with the help of a graphic interface tool and indicator aggregation techniques.

## 1.2 Objectives

The major objectives of this study is to focus on the measurement and assessment of transport activities in the EU 27 by using transport sustainability indicators. On the basis of major selected international transport related indicator initiatives a set of 55 indicators has been developed and 32 indicators have been analysed in quantitative terms. The subsequent steps of the study focus on the quantification of transport sustainability by utilising data from various established transport related databases. This is followed by the measurement and assessment of transport sustainability performance in the EU Member States. It should be noted that in our study a significant part of quantitative transport sustainability indicators focus more on road transport compared to the other transport modes (e.g. energy consumption in road transport, employment in road transport sector, emissions from road transport etc.). This “domination” of road transport in our indicator data set is a result of higher quality and more complete quantitative data availability for road transport compared to other transport modalities.

Indicator aggregation methods have been applied to obtain the *SusTrans Index*. An EC DG Joint Research Centre modelling tool, the so-called “Dashboard of Sustainability”, has been applied to our transport indicator set. This graphic interface is designed to compare indicator groups, to communicate a quick impression and point to areas where indicators show particular success or problems. Thus, it permits to quantitatively assess and to visualise sustainability performance of the EU transport activities within the economic, social and environmental, technical/ operational and institutional sustainability dimensions. Additionally, aiming to benchmark the results of transport sustainability performance obtained from the *SusTrans* indicator set, the Dashboard interface has been applied to the EEA Transport and Environment Reporting Mechanism (TERM) indicators and the *TERM Index* has been developed. This allowed to compare the two transport indicator sets and consequently to perform evaluation of transport activities in the EU Member States with the final aim of achieving a sustainable transportation system in the European Union.

The principal aims of this report include: 1) collection of quantitative data to match the proposed transport sustainability indicators (as they were developed in Part 1 of the report series (Dobranskyte-Niskota *et al.*, 2007). 2) measurement and evaluation of transport sustainability activities in EU 27 with the help of indicator aggregation methodologies and adequate modelling techniques 3) benchmarking of our transport sustainability indicator set (the *SusTrans Index*) against the EEA *TERM* indicators 4) highlighting the strengths and weaknesses of this study.

The report is structured as follows: Section 2 presents the quantitative data sources for measurement of transport sustainability performance using the newly developed transport indicator set. Section 3 defines the major methodological approaches applied in this study which include the application of the “Dashboard of Sustainability” graphic interface and other techniques for the development of aggregate indices. Section 4 is focused on the evaluation of transport sustainability performance in EU27 Member States according to the *SusTrans Index*. Section 5 focuses on the EEA *TERM Index*, which is

then used to benchmark transport sustainability performance of the EU 27. Conclusions are provided in Section 6.

## **2 SUSTAINABILITY INDICATORS FOR MEASUREMENT OF TRANSPORT PERFORMANCE**

The structure of our proposed transport sustainability framework was presented in greater detail in Part 1 of this report series entitled “Indicators to Assess Sustainability of Transport Activities: Review of the Existing Transport Sustainability Indicators Initiatives and Development of an Indicator Set to Assess Transport Sustainability Performance” (Dobranskyte-Niskota, *et al.*, 2007). Therefore, the current report (Part 2 of the report series) only briefly summarizes the composition of the indicator framework. Emphasis is placed on the quantification of the available data using various international data sources. These international data sources defined in the paragraphs below were selected on the basis of their reliability and international recognition, taking into account completeness of data coverage, suitability of time series and interdisciplinarity of quantitative data. Data uncertainty and data availability/ comparability are also discussed in the following paragraphs.

Further in the text we frequently refer to the term – *sustainable transport performance* or *transport sustainability performance*, which refers to the assessment of the state of transport activities taking into account the five sustainability dimensions (economic, environmental, social, technical and institutional). Sustainable transport or transport sustainability we consider “the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future” (EC, 2003).

### **2.1 Structure of Indicator Set**

On the basis of selected major transport related initiatives such as those developed in the frame of the EC Sustainable Development Strategy (a part focused on transport theme indicators), European Transport policy Information System indicators (ETIS), the EEA Transport and Environment Reporting Mechanism Indicators (TERM), the Eurostat transport indicators, transport indicator sets of OECD<sup>1</sup>, US EPA<sup>2</sup>, World Bank<sup>3</sup>, transport database of UNECE<sup>4</sup>, Victoria Transport Policy Institute (VTPI) transport indicators and the JRC Well-to-Wheels study as defined in Dobranskyte-Niskota, *et al.* (2007), a set of 55 indicators has been developed. As already mentioned earlier, it is comprised of 5 sustainability dimensions (namely economic, social, environmental, technical/operational and institutional). Transport is at the heart of all the sustainability components, and Figure 1 graphically indicates the central role of transport activities on all the components (“petals”) of sustainability, which are economic, social, environmental, technical/ operational and institutional dimensions. Due to its shape and structure which helps to clearly understand the impacts of transport, we will refer to this concept as a “Daisy” concept (Figure 1). The 17 indicator themes behind these dimensions are comprised of corresponding indicators integrated into the whole indicator framework structure (Table 1).

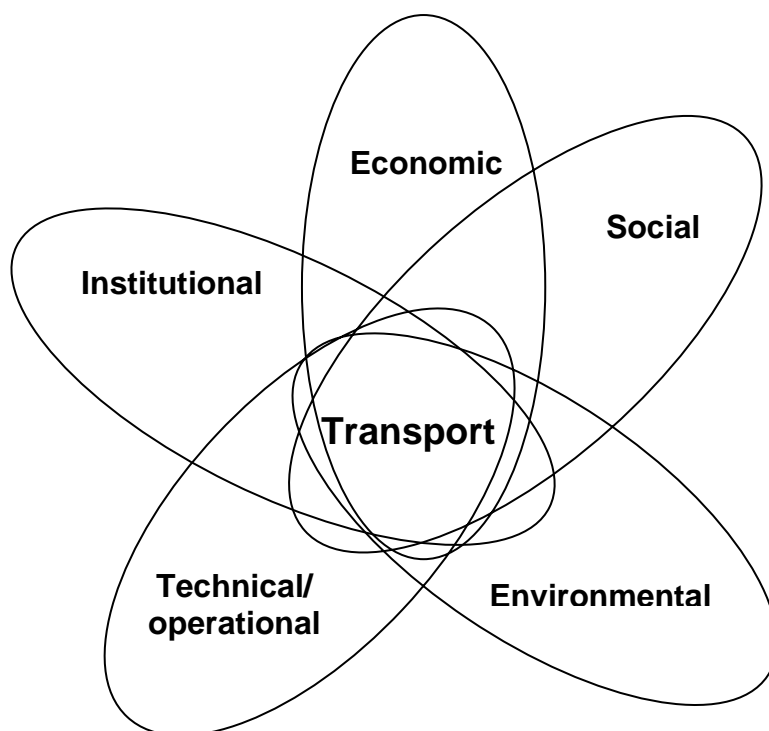
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<sup>1</sup> Indicators for the Integration of Environmental Concerns into Transport Policies

<sup>2</sup> Indicators of the Environmental Impacts of Transportation of United States Environmental Protection Agency

<sup>3</sup> Indicators for Measurement of Transport results, Performance Indicators for Transport

<sup>4</sup> United Nations Economic Commission for Europe



**Figure 1 Transport Sustainability Dimensions and their Interactions (the “Daisy” Concept).**

**Table 1.** Indicator Framework for the Evaluation of Transport Sustainability Performance

DIMENSION	THEME	RELATED INDICATORS
ECONOMIC	<i>Transport Demand and Intensity</i>	1. Volume of transport relative to GDP (tonne-km; passenger-km)
		2. Road transport (passenger and freight; tonne-km and passenger -km)
		3. Railway transport (passenger and freight; tonne-km and passenger-km)
		4. Maritime transport for goods and passengers (tonne-km and passenger-km)
		5. Inland waterway transport (passenger and freight; tonne-km and passenger-km)
		6. Air transport (passenger and freight; tonne-km and passenger-km)
		7. Intermodal transport (tonne-km and passenger-km )
	<i>Transport Costs and Prices</i>	8. Total per capita transport expenditures (vehicle parking, roads and transit services)
		9. Motor vehicle fuel prices and taxes (for gasoline and gas/ diesel)
		10. Direct user cost by mode (passenger transport)
		11. External costs of transport activities (congestion, emission costs, safety costs) by transport mode (freight and passenger)
		12. Internalization of costs (implementation of economic policy tools with a direct link with the marginal external costs of the use of different transport modes)
		13. Subsidies to transport
		14. Taxation of vehicles and vehicle use
		15. % of GDP contributed by transport
		16. Investment in transport infrastructure (per capita by mode/ as share of GDP)
	<i>Infrastructure</i>	17. Road quality - paved roads, fair/ good condition
		18. Total length of roads in km by mode

		19. Density of infrastructure (km-km <sup>2</sup> )
<b>SOCIAL</b>	<i>Accessibility and Mobility</i>	20. Average passenger journey time
		21. Average passenger journey length per mode
		22. Quality of transport for disadvantaged people (disabled, low incomes, children)
		23. Personal mobility (daily or annual person-km and trips by income group)
		24. Volume of passengers
	<i>Risk and Safety</i>	25. Persons killed in traffic accidents (number of fatalities - 1000 vehicle km; per million inhabitants)
		26. Traffic accidents involving personal injury (number of injuries – 1000 vehicle km; per million inhabitants)
	<i>Health Impacts</i>	27. Population exposed to and annoyed by traffic noise, by noise category and by mode associated with health and other effects
		28. Cases of chronic respiratory diseases, cancer, headaches. Respiratory restricted activity days and premature deaths due to motor vehicle pollution
	<i>Affordability</i>	29. Private car ownership
		30. Affordability (portion of households income devoted to transport)
	<i>Employment</i>	31. Contribution of transport sector (by mode) to employment growth
<b>ENVIRONMENTAL</b>	<i>Transport Emissions</i>	32. NOx emissions (per capita)
		33. VOCs emissions (per capita)
		34. PM <sub>10</sub> and PM <sub>2.5</sub> emissions (per capita)
		35. SOx emissions (per capita)
		36. O <sub>3</sub> concentration (per capita)
		37. CO <sub>2</sub> emissions (per capita)
		38. N <sub>2</sub> O emissions (per capita)
		39. CH <sub>4</sub> emissions (per capita)
	<i>Energy Efficiency</i>	40. Energy consumption by transport mode (tonne-oil equivalent per vehicle km)
		41. Fuel consumption (vehicles-km by mode)
	<i>Impacts on Environmental Resources</i>	42. Habitat and ecosystem disruption
		43. Land take by transport infrastructure mode
	<i>Environmental Risks and Damages</i>	44. Polluting accidents (land, air, water)
		45. Hazardous materials transported by mode
	<i>Renewables</i>	46. Use of renewable energy sources (numbers of alternative-fuelled vehicles) - use of biofuels
<b>TECHNICAL and OPERATIONAL</b>	<i>Occupancy of Transportation</i>	47. Occupancy rate of passenger vehicles
		48. Load factors for freight transport (LDV, HDV)
	<i>Technology Status</i>	49. Average age of vehicle fleet
		50. Size of vehicle fleet (vehicle/ 1 mln. inhabitants)
		51. Proportion of vehicle fleet meeting certain air emission standards (Euro IV, Euro V etc.)
<b>INSTITUTIONAL</b>	<i>Measures to Improve Transport Sustainability</i>	52. R&D expenditure on “eco vehicles” and clean transport fuels
		53. Total expenditure on pollution prevention and clean-up
		54. Measures taken to improve public transport
	<i>Institutional Development</i>	55. Uptake of strategic environmental assessment in the transport sector

A more detailed explanation of this indicator framework and the logics behind the themes of indicators as already mentioned is provided in the Part 1 of the report (Dobranskyte-Niskota, *et al.*, 2007).

## 2.2 Data Sources for Quantification of Indicators

As shown in Table 2, quantitative data sources which were used for quantification of transport indicator framework (which we have named the *SusTrans*) are mainly based on various European databases such as Eurostat and other well-known European databases, which include the RAINS (or the GAINS) model as well as the EEA (“Circa” database). The data is focused on the two years, namely 2000 and 2005, which allows assessing transport sustainability performance trends achieved during the five year period in the EU 27. The data we have obtained (where it was possible) represents each EU 27 Member State. The paragraphs below define the above mentioned databases in more detail. This helps to understand the suitability and reliability of this data for the quantification process of the *SusTrans* indicator framework.

Table 2 is divided into the three major parts, where one part reveals transport indicators of the originally proposed indicator set, the second column comprises indicator proxies which were obtained on the basis of the available data and the final column indicates quantitative data sources used for this study.

**Table 2.** Availability of Data used for the SusTrans Indicator Framework

Dimensions	Transport Indicators	Available Corresponding Data	Indicator Data Sources
Economic dimension	1. Volume of transport relative to GDP (tonne-km; passenger -km)	1. Volume of freight transport relative to GDP (tonne-km per GDP)	Eurostat
	2. Road transport (passenger and freight; tonne-km and passenger -km)	2. Road freight vehicle fleet (% in total inland freight tonne-km); Passenger cars, busses (% in total inland passenger-km)	Eurostat
	3. Railway transport (passenger and freight; tonne-km and passenger-km)	3. Railway freight transport (% in total inland freight tonne-km); All trains (passenger transport) (% in total inland passenger-km)	Eurostat
	4. Maritime transport for goods and passengers (tonne-km and passenger-km)	4. Maritime transport-Goods (gross weight) (1000 tonnes/ GDP); Maritime passenger transport (1000 passengers/ pop).	Eurostat
	5. Inland waterway transport (passenger and freight; tonne-km and passenger-km)	5. Inland waterway freight transport (% on inland freight tonne-km)	Eurostat
	6. Air transport (passenger and freight; tonne-km and passenger-km)	6. Air transport passengers (total passengers on board); Air transport (freight and mail air transport) (tonnes).	Eurostat
	7. Intermodal transport (tonne-km and passenger-km )	N/A	N/A
	8. Total per capita transport expenditures (vehicle parking, roads and transit services)	7. Total per capita transport expenditures (€ pop)	Eurostat
	9. Motor vehicle fuel prices and taxes (for gasoline and gas/ diesel)	8. Motor vehicle fuel prices (€/per litre)	Eurostat
	10. Direct user cost by mode (passenger transport)	9. Direct user cost by mode (passenger transport (€ pop)	Eurostat/ EEA
	11. External costs of transport activities (congestion, emission costs, safety costs) by transport mode (freight and passenger)	N/A	Infras, ITF



	12. Internalization of costs (implementation of economic policy tools with a direct link with the marginal external costs of the use of different transport modes)	N/A	N/A
	13. Subsidies to transport	N/A	N/A
	14. Taxation of vehicles and vehicle use	10.Excise duty on road transport fuels (petrol, diesel) (€/per 1000 litres)	DG TREN, DG TAXUD
	15. % of GDP contributed by transport	11.% of GDP contributed by transport	Eurostat
	16. Investment in transport infrastructure (per capita by mode/ as share of GDP)	12.Investment in transport infrastructure	Eurostat/ ITF
	17. Road quality - paved roads, fair/good condition	13.Total length of roads (railways, motorways) (km of infrastructure per 1000 inhabitants); Density of infrastructure (km of infrastructure per 1000 km <sup>2</sup> of surface area).	Eurostat
	18. Total length in km by mode		
	19. Density of infrastructure (km-km <sup>2</sup> )		
Social dimension	20. Average passenger journey time	N/A	N/A
	21. Average passenger journey length per mode	N/A	N/A
	22. Quality of transport for disadvantaged people (disabled, low incomes, children)	N/A	N/A
	23. Personal mobility (daily or annual person-miles and expenditure on trips by income group)	14.Trends in share of transport household expenditures (%)	Eurostat
	24. Volume of passengers	15.Volume of passengers	Eurostat
	25. Persons killed in traffic accidents (number of fatalities -1000 vehicle km; per million inhabitants)	16. Persons killed in traffic accidents (persons per million of pop)	CARE, EEA, Eurostat
	26.Traffic accidents involving personal injury (number of injuries – 1000 vehicle km; per million inhabitants)	17.Traffic accidents involving personal injury	Eurostat
	27. Population exposed to and annoyed by traffic noise, by noise category and by mode associated with health and other effects	N/A	N/A
	28. Cases of chronic respiratory diseases, cancer, headaches. Respiratory restricted activity days and premature deaths due to motor vehicle pollution	N/A	N/A
	29. Private car ownership	N/A	N/A
	30. Affordability (portion of households income devoted to transport)	N/A	N/A
	31. Contribution of transport sector (by mode) to employment growth	18.Employment in road and rail transport sectors	Eurostat
Environmental dimension	32. NOx emissions (per capita)	19.NOx emissions from mobile sources	RAINS
	33. VOCs emissions (per capita)	20.VOC emissions from road transport and NRMM	RAINS
	34. PM <sub>10</sub> and PM <sub>2.5</sub> emissions (per capita)	21.PM <sub>10</sub> and PM <sub>2.5</sub> emissions from road transport and NRMM	RAINS
	35. SOx emissions (per capita)	22.SO <sub>2</sub> emissions from road transport and NRMM	RAINS

	36. O <sub>3</sub> concentration (per capita)	23.Emission of tropospheric ozone precursors (Tropospheric ozone formation potential (TOFP) equivalent)	Eurostat
	37. CO <sub>2</sub> emissions (per capita)	24.CO <sub>2</sub> emissions from road transport and NRMM	RAINS
	38. N <sub>2</sub> O emissions (per capita)	25.N <sub>2</sub> O emissions from road transport and other transport	Eurostat
	39. CH <sub>4</sub> emissions (per capita)	26.CH <sub>4</sub> emissions from road transport and other transport	Eurostat
	40. Energy consumption by transport mode (tonne-oil equivalent per vehicle km)	27.Energy consumption by road, air, rail and inland navigation transport (1000 tonnes of oil equivalent/ GDP) Energy efficiency of transport (100 toe/ GDP)	Eurostat
	41. Fuel consumption (vehicles-km by mode)	28.Fuel consumption	RAINS
	42. Habitat and ecosystem disruption	N/A	N/A
	43. Land take by transport infrastructure mode	N /A	N/A
	44. Polluting accidents (land, air, water)	N/A	N/A
	45. Hazardous materials transported by mode	N/A	N/A
	46. Use of renewable energy sources (numbers of alternative-fuelled vehicles) - use of biofuels	29.Use of renewable energy sources in transport (1000 tons/ GDP)	Eurostat
	47. Occupancy rate of passenger vehicles	N/A	N/A
<b>Technical and Operational dimension</b>	48. Load factors for freight transport (LDV, HDV)	30.Cross-trade road goods transport performed by haulers.	Eurostat
	49. Average age of vehicle fleet	31.Average age of vehicle fleet (years)	TREMOVE
	50. Size of vehicle fleet (vehicle/ 1 mln. inhabitants)	N/A	N/A
	51. Proportion of vehicle fleet meeting certain air emission standards (Euro IV, Euro V etc.)	32.Ratio between passenger car new registrations and the passenger car fleet (%)	TREMOVE
	52. R&D expenditure on “eco vehicles” and clean transport fuels	N/A	N/A
<b>Institutional dimension</b>	53. Total expenditure on pollution prevention and clean-up	N/A	N/A
	54. Measures taken to improve public transport	N/A	N/A
	55. Uptake of strategic environmental assessment in the transport sector	N/A	N/A

We have considered indicators non available where the indicator data was vague or the data set was extremely incomplete for the individual EU27 Member States. As it can be observed from Table 2, large part of quantitative data for the *SusTrans* indicator framework, especially the data for economic, social, technical/ operational dimensions, was obtained from the online available **Eurostat**<sup>5</sup> transport database. This database includes various European transport statistics of major transport modes, taking into account such aspects as infrastructure, transport equipment, economic performance of transport, role of transport in the employment as well as other issues such as passengers, goods and accidents. It must be noted that the majority of the quantitative data used in our study is based on real-world data, using Eurostat as a major data source. Only emission data (except of O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> emissions) as

<sup>5</sup> Available from: [http://epp.eurostat.ec.europa.eu/portal/page?\\_pageid=0.1136228,0\\_45572945&\\_dad=portal&\\_schema=PORTAL](http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0.1136228,0_45572945&_dad=portal&_schema=PORTAL)

well as data based on vehicle fleet age and vehicle fleet meeting air emission standards are “synthetic” indicators obtained from modelling activity as these data sets were most complete and very close to the real-world data when compared to the adequate real-world data sources. Transport emissions and fuel consumption data for the indicators within the environmental dimension in this current study were mainly obtained from public accessible IIASA website- Greenhouse Gas and Air Pollution Interactions and Synergies (the **GAINS Europe**) model<sup>6</sup>, which provides a consistent framework for the analysis of co-benefits reduction strategies from air pollution and greenhouse gas sources. One of the recent versions (February 2008) of the GAINS model has been used for extracting the emission data. Specifically, emission data (in particular for the emissions of NO<sub>x</sub>, VOC, PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub> and CO<sub>2</sub>) was obtained from the new GAINS baseline policy scenario reflecting current EU legislation, the so-called **C&E package, Current Policy (NEC Report Nr.6)**. This baseline scenario takes into account effects of a wide range of European and national legislation for reducing emissions, against the background of future economic development. Such baseline scenario may be also called the “business-as-usual” or “current legislation” scenario (EC, 2005). The current EU legislation defined within this baseline scenario includes the EU National Emissions Ceilings Directive (NEC) (2001/81/EC) and PRIMES energy model baseline scenario which includes pollution burden sharing policy. The data related to fuel consumption indicators was extracted from the recent GAINS (RAINS) national scenario, namely **NEC\_NAT\_CLEV4 (NECO4)**. Although this baseline scenario is also close to the current legislation, it is based on national data provided by EU Member States in the context of fuel consumption and is, therefore, considered to be adequate for the analysis of fuel data. This specific scenario includes also the EU NEC Directive (2001/81/EC). Abbreviations NAT stands for national provided data, CLE reflects the current legislation and V4 means the 4<sup>th</sup> version of the baseline policy scenario (IIASA, 2007). Other important data source used for obtaining quantitative data for our transport indicator framework are the **EEA TERM** data fact sheets using “eionet<sup>7</sup>-circle” Communication & Information Resource Centre Administration<sup>8</sup> (**CIRCA**) System, which is an online data storage service where the EEA TERM data is being collected.

The remaining data sources include the European Commission’s Directorate-General for Energy and Transport (EC DG-TREN), the European Commissions Directorate-General Taxation and Customs Union (EC DG-TAXUD), the European Renewable Energy Council (EurObservER), the European Accident database (CARE), Tremove - environmental and transport model database, the European Environmental Agency (EEA) TERM database and International Transport Forum (ITF).

Table 2 also shows that depending on data availability, corresponding indicators may slightly differ from the originally proposed transport sustainability indicators (in this way they are proxy indicators). Thus, in Table 2 additional column is introduced indicating the available corresponding data. It shows how the originally proposed indicators and their measurement units change depending on data availability.

## 2.3 Data Availability, Reliability and Uncertainties

Indicator quality criteria reflected in the policy documents of the international organizations commonly state that indicators must be clear and understandable, policy relevant, accessible, and reliable, and the indicator data must be accurate. In reality it is quite difficult to meet all these criteria. Table 2 shows that it is not always possible to obtain the quantitative data as not all the indicators from our transport sustainability indicator framework have matching indicator data. This is mainly due to the availability of data and limitations of translating certain variables into quantitative terms (e.g. costs of externalities such as congestion, noise etc.). For example, it is widely known that environmental assets as well as social patterns are difficult to estimate in monetary and other quantitative terms (Perman *et al.*, 1999).

<sup>6</sup> Available from: <http://www.iiasa.ac.at/web-apps/apd/gains/EU/index.login?logout=1>

<sup>7</sup> European Environment Information and Observation Network

<sup>8</sup> Available from: <http://eea.eionet.europa.eu:80/Members/irc/eionet-circle/Home/main>

For the SusTrans indicator framework we have selected reliable data sources on the basis of generally accepted indicator quality selection criteria. For example our major data source is Eurostat - the official statistical office of the EU which has a mission to collect the data from official national statistical offices of the EU Member States. The data collection methodology of Eurostat database is in conformity with the IMF/ UN Special Data Dissemination Standard (SDDS), based on four major principles: 1) the data coverage, periodicity, and timeliness; 2) access by the public; 3) integrity of the disseminated data; 4) quality of the disseminated data. Emission and fuel consumption data we have obtained from the GAINS model (former RAINS model), which has been selected as a data source for the current analysis due to its' international recognition in terms of assessment of emission inventories of different sectors (which also include transport) and the wide use of this model. The choice takes into account the fact that the GAINS (the RAINS) model has been also chosen by other European Commission services as scientific and technical basis for CAFE (Clean Air for Europe) Programme for integrated policy advices. The EC has recognized the GAINS model as a reliable scientific tool for policy recommendations. Several technical indicator data regarding the vehicle age and passenger car new registrations have been obtained from TREMOVE model database (a specific model addressing the policy issues of transportation). The remaining data for our indicator framework was collected on the basis of the Eionet system using CIRCA as a tool for the extraction of data composed by the EEA. The Eionet network works in partnership with EEA which includes 900 experts and more than 300 national institutions, supporting the collection and organization of data and the development and dissemination of information concerning Europe's environment.

However, data uncertainties still play a challenging role, especially when we take into account the data generated by computer models. The CORINAIR guidelines (1996) state that all emission estimates are based on the mixture of hard facts and a number of assumptions. In order to reduce the number of assumptions that provide uncertainties it is important to define a method for calculating emissions which would be based on as many hard facts as possible. Thus, regarding the GAINS and TREMOVE models it may be said that although it gives a large degree of flexibility, the limitations of the model mainly regards the management of uncertainties. This relates to biases caused by simplifications, assumptions and setting of boundary conditions, statistical uncertainties due to incompleteness in data collection and uncertainties in the socio-economic and technical development.

As shown in Table 2 the data for the institutional dimension of transport sustainability is completely absent, as it is unavailable for the individual EU27 Member States. The institutional dimension of transport sustainability is highly important in terms of efficient implementation and functioning of the sustainability policies and strategies. Thus, in the future, once appropriate quantitative institutional data becomes available for the EU Member Countries this aspect needs to be strengthened. This would allow for a better control of transport activities and more efficient implementation of transport sustainability strategies.

### 3 METHODOLOGICAL APPROACHES

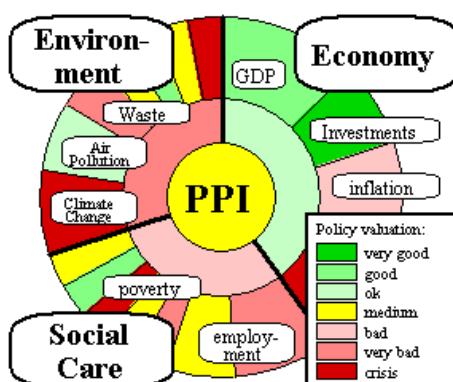
This chapter centres on the methodology of aggregating individual indicators to meaningful synthetic information. To illustrate methodology and results, we will use the “Dashboard of Sustainability” software, a tool specially designed to visualise complex indicator sets. The paragraphs below introduce the specificities of the software, focusing on its structure and its application for assessing transport sustainability performance in the EU 27. In addition, other methodological steps such as normalization, standardization and aggregation of indicator weights, commonly used in the quantification of indicators, are also presented.

#### 3.1 The Dashboard of Sustainability

The “Dashboard of Sustainability” graphic interface is an online tool<sup>9</sup> for non-commercial use, designed to compare various indicator groups, to communicate a quick impression and point out to areas where indicators show particular success or problems (JRC/IISD, 2006). In other words, the Dashboard, developed at the European Commission’s DG Joint Research Centre, is a visual presentation tool and displays the primary dimensions of sustainability through a set of indicators relating to social, environmental, economic, and institutional clusters (Hardi, 2002). As described in the literature, the “Dashboard of Sustainability” has been used in the evaluation of various international sustainability indices or indicator sets such as the Environmental Sustainability Index (ESI), the Ecological Footprint, the Millennium Development Goals (MDG’s) and others. These diverse applications confirm that it is a universal presentation tool for indicators applied by various constituencies. As the complexity of decision-making in the 21<sup>st</sup> Century requires more adequate policy support tools (Jesinghaus, 2007), such graphic interface may as well be successfully applied to assess sustainability performance of transport activities in the EU 27.

One main feature of the “Dashboard of Sustainability” is the presentation of indicators in a simple pie chart based on three “language elements”:

- 1) the size of a segment reflects the relative importance of the issue described by the indicator,
- 2) colour codes signal relative performance, with green meaning “good” and red meaning “bad”,
- 3) a central circle, the *Policy Performance Index* (PPI), summarizes the information of the component indicators.



**Figure 2** The example of the “Dashboard of Sustainability” indicator representation (Source: Jesinghaus, 2007).

<sup>9</sup> Available from: <http://esl.jrc.it/dc/index.htm>

On the basis of these rules, the “Dashboard of Sustainability” allows the presentation of complex relationships in a comprehensive form, understandable to non-experts, to perform a quick assessment of the weak and strong points of each nation compared to other nations in the same “league”. The tool assigns a colour-code for communicating performance, offers a comparative view, constructs a distribution of each indicator, generates colour-coded maps and performs the analysis of inter-indicator links. Most applications compare nations, but the tool can be analogously used to display urban or regional indices. The software’s point system ranges from 0 (worst case, dark red) to 1000 points (best country or city, dark green). All other values are calculated by linear interpolation between these extremes. For each indicator, its distribution can be displayed, thus, allowing the user to assess the meaningfulness of the indicator and to identify outliers etc. Analysis of linkages between the indicators for each pair of indicators may be presented in a scatter plot correlation as we have done in our study. A list of indicators, sorted by “best fit”, allows identifying the most relevant linkages (example: surprisingly, “CO<sub>2</sub> emissions of transport” are negatively correlated with “Persons killed by road accidents”, i.e. countries with *low* CO<sub>2</sub> emissions present *high* mortality). In particular, this function allows identifying synergies (indicators whose “desirable” values are positively correlated) and potential conflicts (e.g. environment vs. many economic and social variables). The practical application of the Dashboard tool in our study is presented in the Chapters 4 and 5, where the results of transport sustainability performance in the EU27 are displayed.

### 3.2 Indicator Standardization and Normalization

Indicators are commonly understood as ratios of two adequate components that help to measure the trends and indicate the signals. Standardization of indicators is needed to facilitate inter-country comparisons. To date there is no standard harmonised method established of how indicators should be standardized, however the OECD (2003) has proposed certain principles, devoted to analytical and evaluation work of indicators. When comparing indicators across countries, the outcome of the assessment will depend on the chosen denominator methodologies (most commonly used denominators are GDP, population and area in square km) as well as on national definitions and measurement (OECD, 2003). Similarly, aiming to facilitate the aggregation of variables into indicators the recently proposed Environmental Sustainability Index (2007) transfers the raw data in order to make it more comparable. This is carried out by identifying common denominators. However, to identify a few standard denominators which can be applied to transport indicators it is not as simple because transport topic in general is very diverse and complex. Thus, when it was possible in our study we have applied the above mentioned standard denominators such as GDP and population. Where it was not possible we have used the denominators proposed by the original data sources.

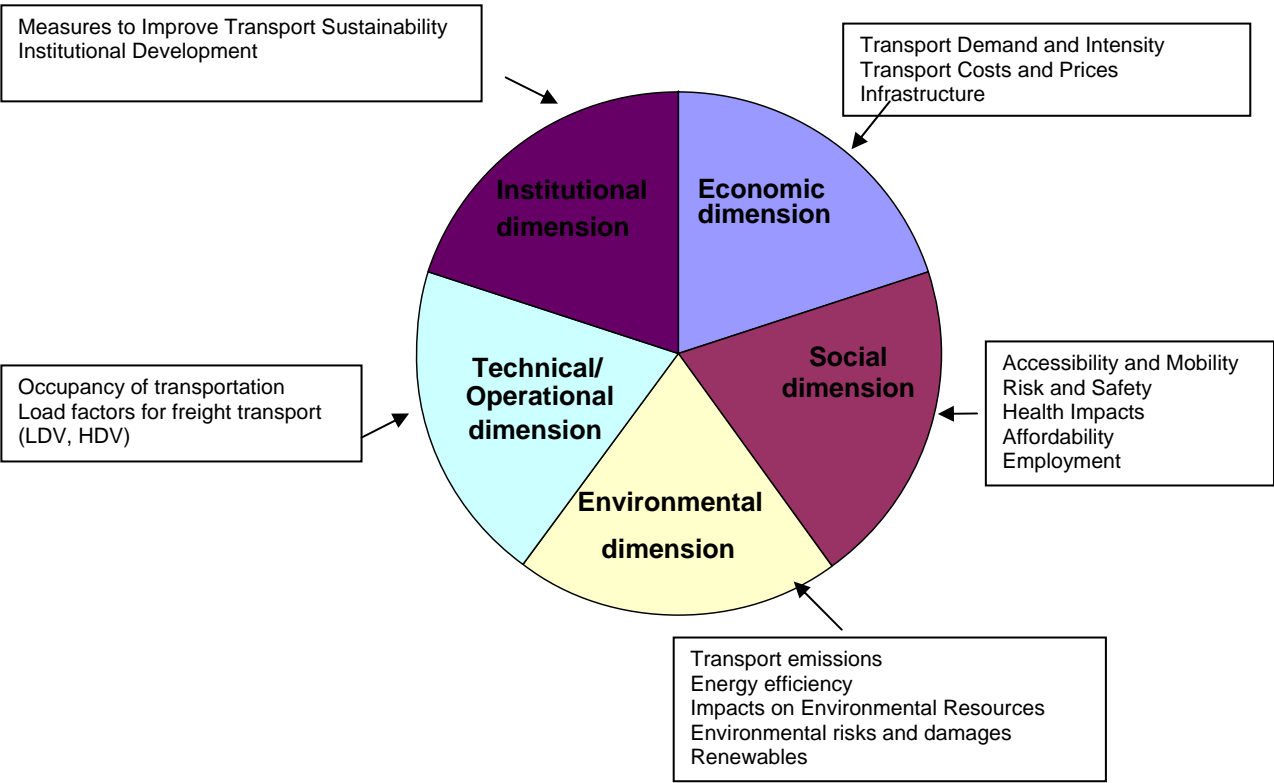
Once standardized, the data needs to be normalised in order to transform the selected transport sustainability indicators into comparable scales. In the literature there are several methods of normalising the data (e.g. Nardo *et al.*, 2005). In our study we have applied the normalisation method which is normally used by the “Dashboard of Sustainability”. For standardization and normalization of its variables the Dashboard uses a system of points, ranging from 0 (worst case, dark red) to 1000 points (best country or city, dark green). All other values are calculated by linear interpolation between these extremes using the MinMax formula. For example, the points for NO<sub>x</sub> emissions are calculated as follows:  $1000 \cdot (x - \text{worst}) / (\text{best} - \text{worst})$ ; best=6.66 (Slovakia), worst=79.7 (Luxemburg); with 14.9 kt per mln population, Italy receives 887 points:  $P = 1000 \cdot (14.9 - 79.7) / (6.66 - 79.7)$ .

### 3.3 Aggregation of Indicator Weights

Adequately distributing weights and finding a common denominator for the composite sustainability components is a usual difficulty of all aggregate indices. The most common approach to aggregation is to take an equally weighted average (EWA) of the variables. This way of aggregation has been applied to numerous sustainability indices such as Human Development Index, Environmental Sustainability Index, etc. The EWA way of aggregation according to the developers of Environmental Sustainability Index (2005) is the most transparent way of combining the three-dimensional information into one

measurement. As EWA method is widely used in the development of various international and well-known aggregate indices, we have also considered this way of indicator weight aggregation as a suitable solution for the development of our *SusTrans Index*. The “Dashboard of Sustainability” also uses by default the EWA method, i.e. it gives the same weight to all indicators. The three circles (economy, social care and environment) as shown in the dashboard example, in Figure 1, are given equal weights for the aggregation into the overall "Policy Performance Index" (PPI). However, obviously the method of EWA is not the most perfect as not all the indicators have the same importance. Summarizing weights of these different components involves value judgment, which is open to criticism. One may argue that EWA procedure means assuming total substitutability between variables which is hardly a realistic assumption. Nardo et al. (2008) suggest various other ways of applying the weighting coefficients using other methodologies. These alternative aggregation methods may include the Edges method and surveys among experts (economists, social and environmental scientists) and the general population, using a simple Budget Allocation Process (BAP). The Edges method (Despic, 2000; Marichal *et al.*, 2000) is a Multi Criteria Decision Making (MCDM) method that allows to process better partially conflicting and synergic information (e.g. dealing with sustainability indicators). The Edges method is based on weights to be given, not only to the single variables as in the EWA method, but also to combination of variables.

Figure 3 in a simple way shows the example of EWA method used in our study, where indicators are equally averaged to obtain the values of the five dimensions of transport sustainability. The resulting values are then equally averaged to obtain the sustainability score of transport performance (*the SusTrans Index*).



**Figure 3 Equal Distribution of Indicator Weights within the SusTrans Index.**



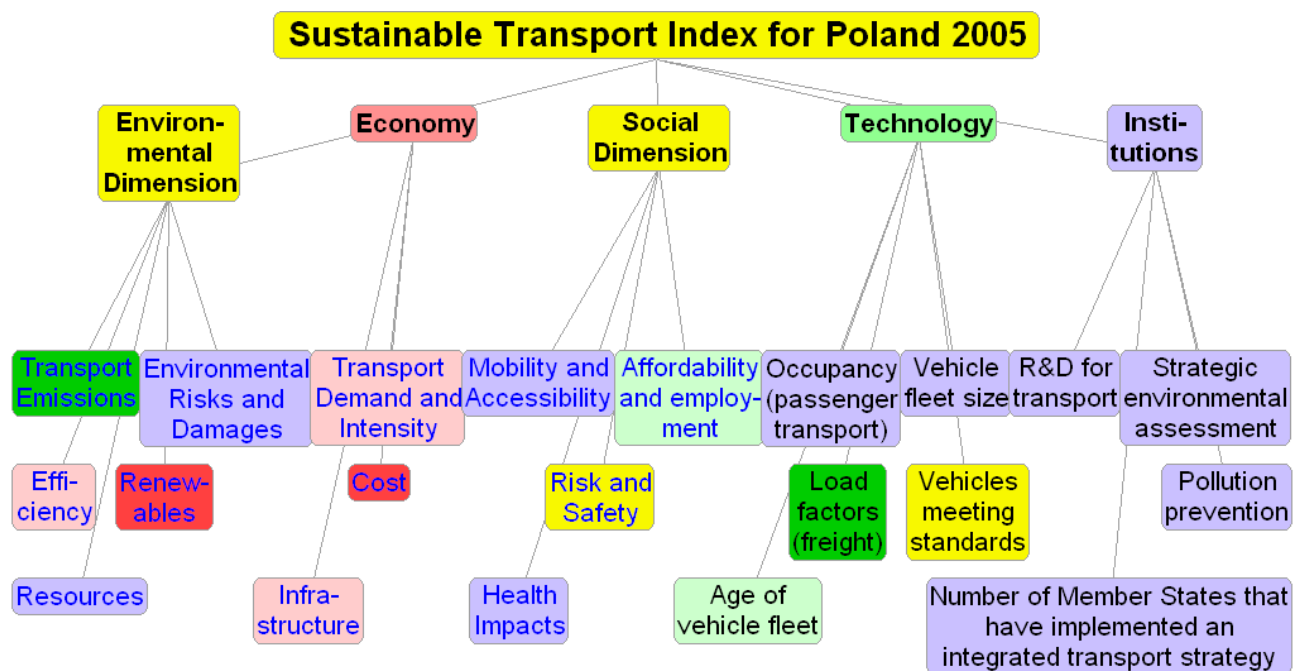
## 4 EVALUATION OF TRANSPORT SUSTAINABILITY PERFORMANCE BY SUSTRANS INDEX

This chapter focuses on the results obtained with our transport indicator set. The sections below are grouped according to the transport sustainability dimensions (the “Daisy” Concept) following the structure of the *SusTrans* indicator framework. The quantitative and graphic information presented reflects the situation (weaknesses and strengths in transport performance) in the individual EU 27 Member States. Additionally, the evaluation of the EU 27 Member States based on the *SusTrans Index* during the period from the year 2000 to 2005 showing the trends is presented.

In the text we discuss and refer to the major dimensions of the *Sustrans Index* as separate indices (e.g. economic transport sustainability index, social transport sustainability index etc.). Comprising parts of these indices in our study are called indicators or composite indicators.

### 4.1 The SusTrans Index: Composition and Distribution

Figure 4 demonstrates the five-dimensional structure of transport sustainability, which consists of 5 components, 17 themes and 32 indicators. As previously mentioned quantitative data is unavailable for the fifth component - the institutional transport sustainability dimension (blue signals “no data”). Thus, due to the lack of these data, in the current report only four sustainability dimensions, namely economic, social, environmental and technical, are presented in quantitative terms. The data unavailability for the institutional transport sustainability dimension suggests that institutional aspect needs to be strengthened in terms of quantification possibilities in the near future by data collecting agencies. This would allow for more complete evaluation of transport sustainability performance in the EU.



**Figure 4 The overall structure of the JRC SusTrans Index, using data for Poland in 2005**

Note the graph covers only the first two aggregation levels; legends in blue colour are aggregates themselves, e.g. “Efficiency” is composed of six underlying indicators that can be displayed separately or in the context of the full structure, although at the expense of legibility. Although the original structure of the *JRC SusTrans Index* includes 55 indicators, in reality only 32 indicators have been identified having available data and, thus, are presented in quantitative terms. Figure 5 shows the five-



dimensional composition of index and distribution of weights using the EWA (equal weight distribution) approach.

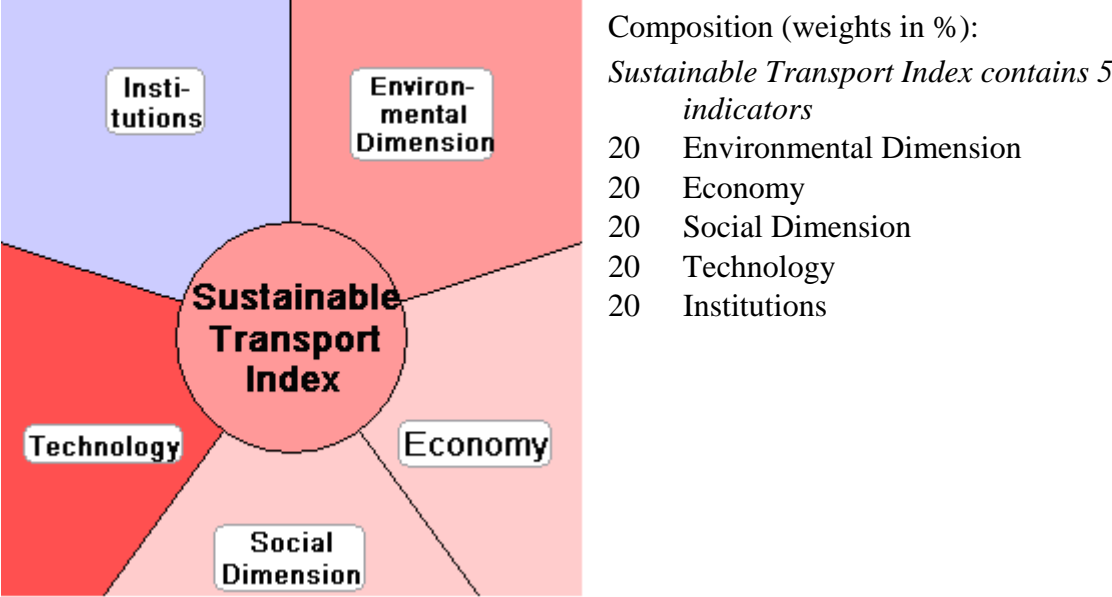


Figure 5 Five-dimensional Composition of the JRC SusTrans Index.

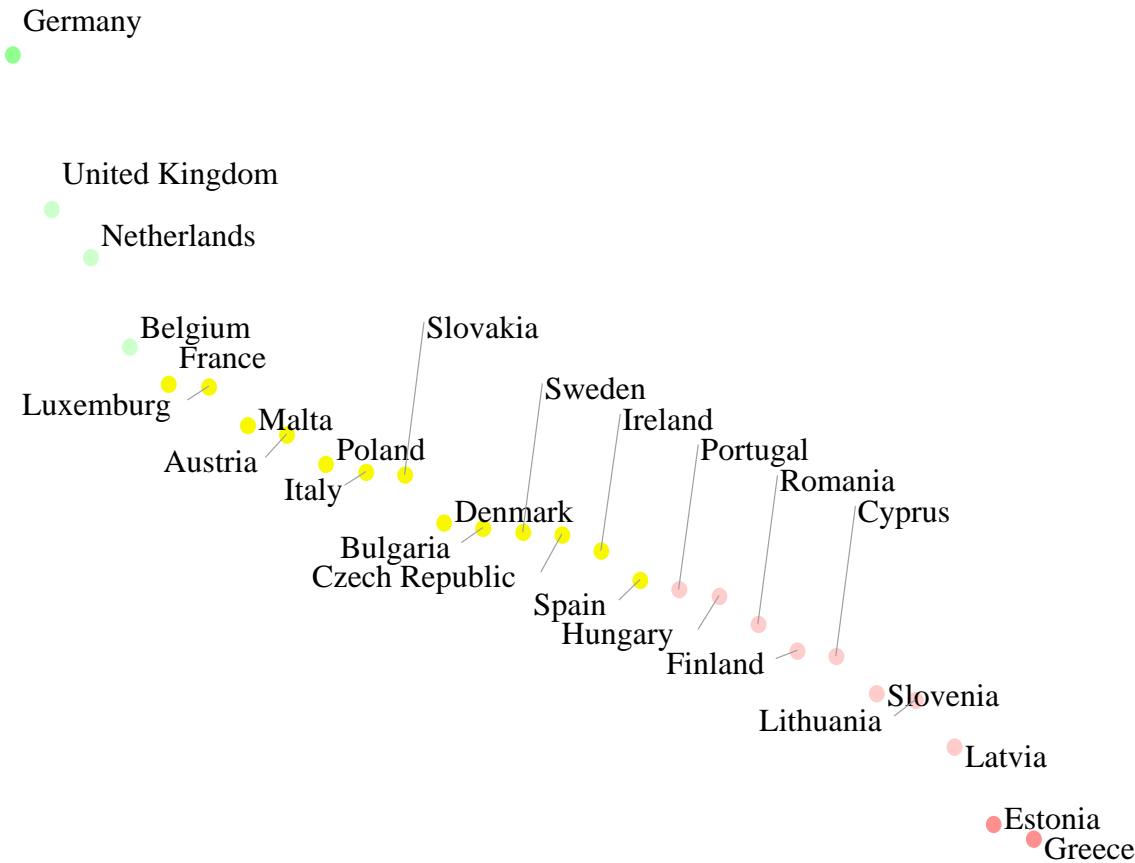


Figure 6 Ranking of the EU Member States according to the JRC SusTrans Index.

On the basis of quantitative data which has been collected from various international databases, as explained in Chapter 2 of this report, the “Dashboard of Sustainability” tool has calculated the ranking of the EU Member States on the basis of the *SusTrans Index*. Figure 6 shows that the best performance

of sustainable transport activities in the year 2005 has been achieved in Germany and the lowest rank among the EU Member States in transport sustainability performance is observed in Greece. Figure 7 reveals transport sustainability performance distribution visualized in the EU map (green color indicates the best performance, yellow – medium, red – the lowest performance score).



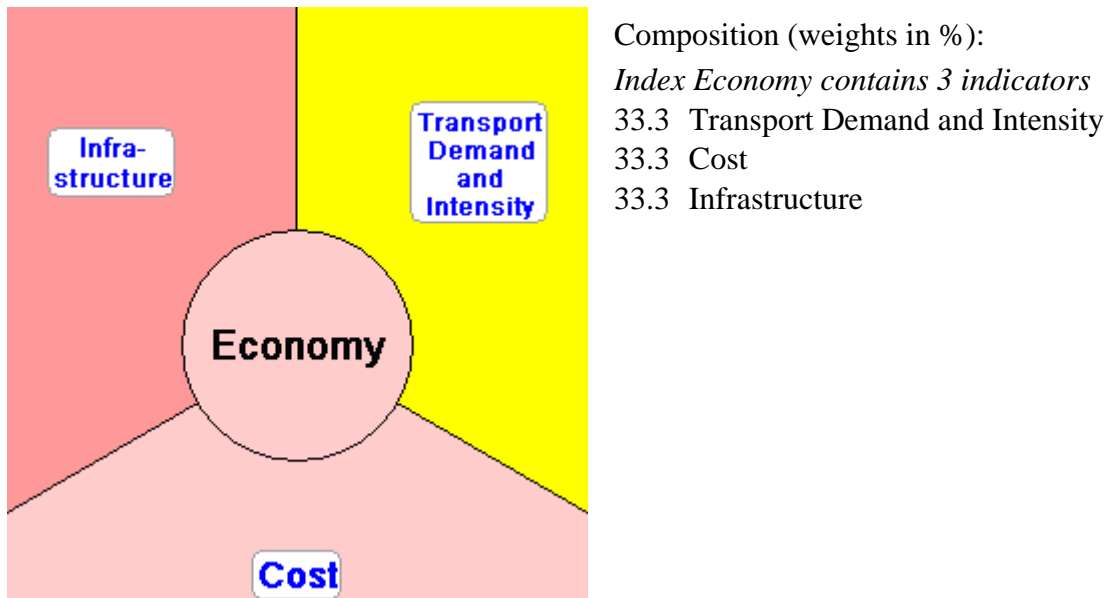
**Figure 7 Transport Sustainability Performance in the EU Member States (green color denotes high sustainability performance, yellow- medium and red - low performance).**

As it can be observed in Figure 7, the best scores in the overall transport sustainability performance has been obtained by Germany, followed by the UK and France. A medium level of transport sustainability performance may be observed mainly in the Central and Southern EU Member States. Low sustainability performance is observed in Greece and in Romania. The Northeastern part of Europe, in particular the Baltic States and Finland, also have a low level of sustainability of transport activities. This is probably because the New EU Member States had much more transport intensive economies with a historical focus on industrial and agricultural production but are now in transition towards more service oriented economies, like those in the EU-15 (EEA, 2004).

The overall transport sustainability score and the ranking of transport sustainability performance of the EU Member States provide a general picture of transport activities in Europe. In order to be able to understand the specific aspects and the major issues related to transport activities in the EU Member States, it is necessary to analyze each sustainability dimension separately and to look at each individual indicator. In the *JRC SusTrans Index* each sustainability dimension is represented by the corresponding aggregated sustainability index (e.g. economic transport sustainability index, social transport sustainability index, etc.). Please note that in all figures presented in the report we refer to the year 2005, unless differently stated.

## 4.2 Economic Transport Sustainability Performance

This section focuses on the economic transport sustainability performance in the EU Member States. It is represented by the *Economic Transport Sustainability Index* calculated with the Dashboard tool. As it can be observed from Figure 8, the structure of economic transport sustainability dimension refers to three composite indicators which deal with *transport demand and intensity*, *transport costs* and *infrastructures*. The figure shows equal distribution of indicator weights within this dimension. Additionally, Figure 9 presents all the indicators of the economic dimension of the *SusTrans Index*, which are analyzed in greater detail in the paragraphs below.



**Figure 8 Composition of the Economic Transport Sustainability Index.**

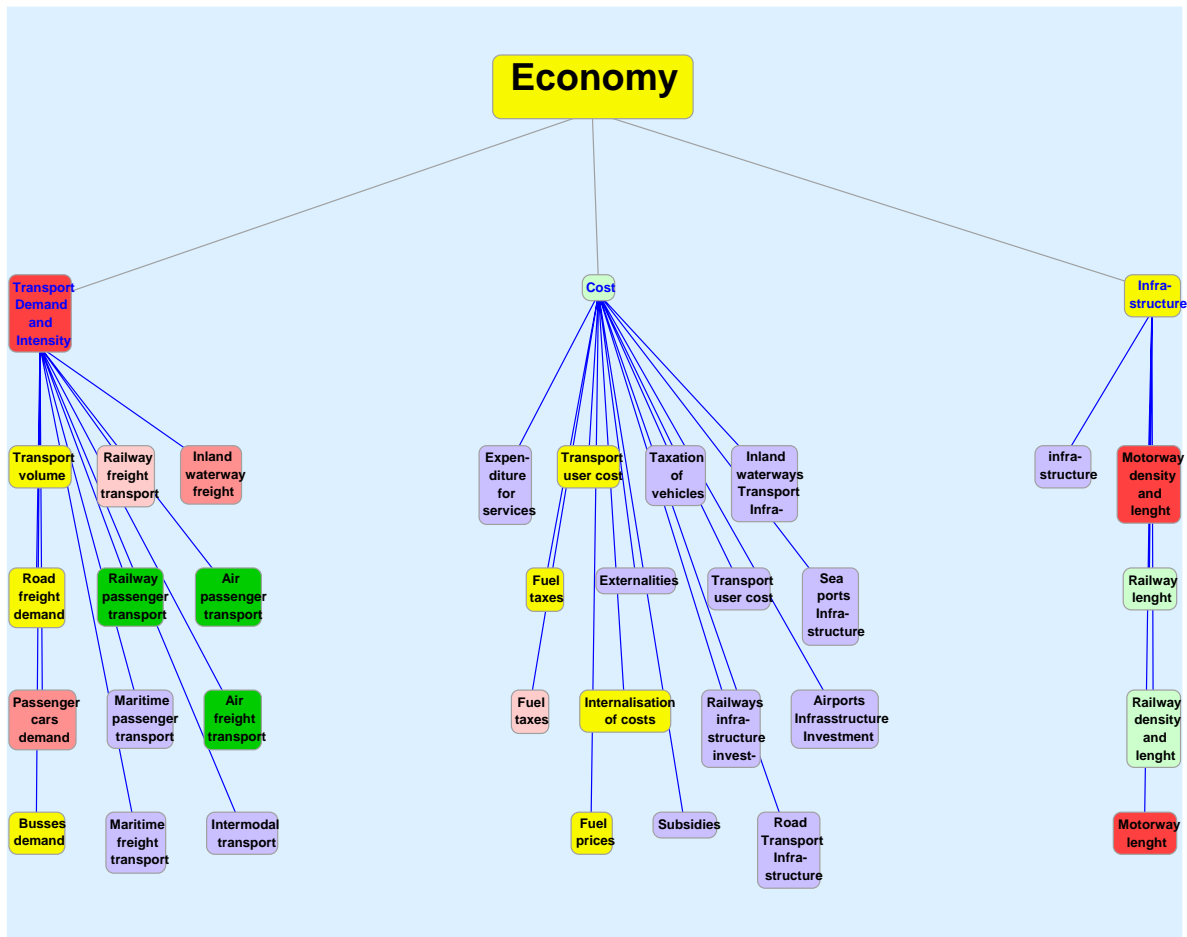


Figure 9 Structure of the Economic Transport Sustainability Index.

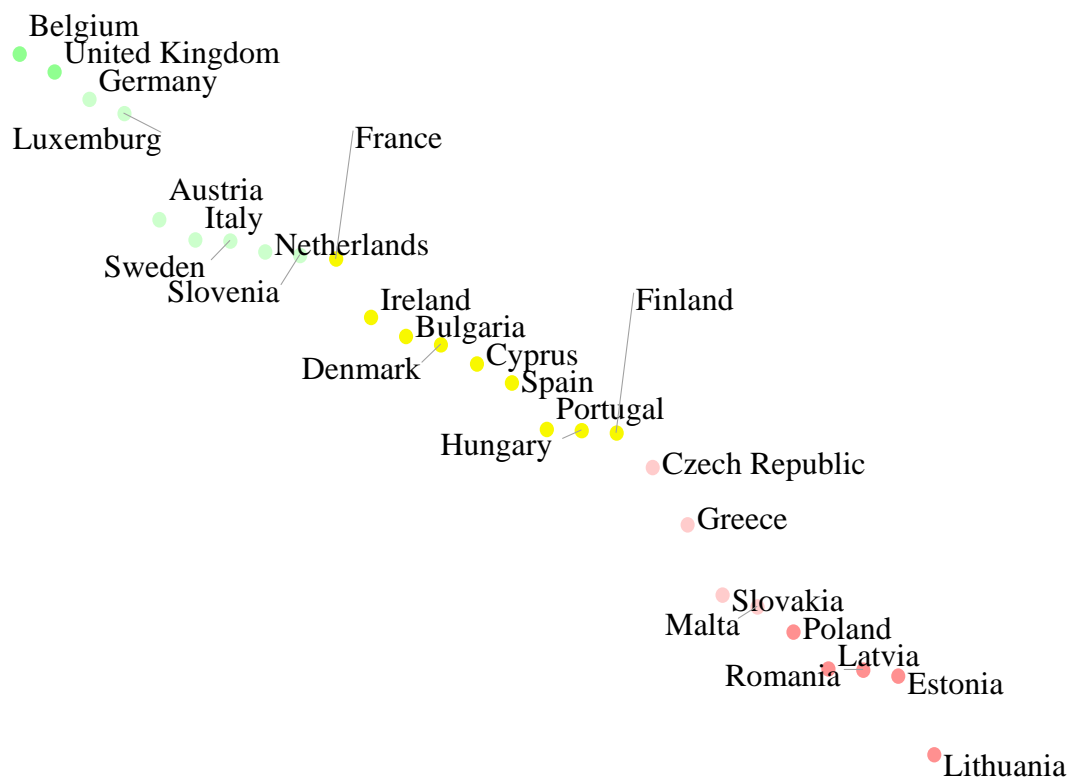
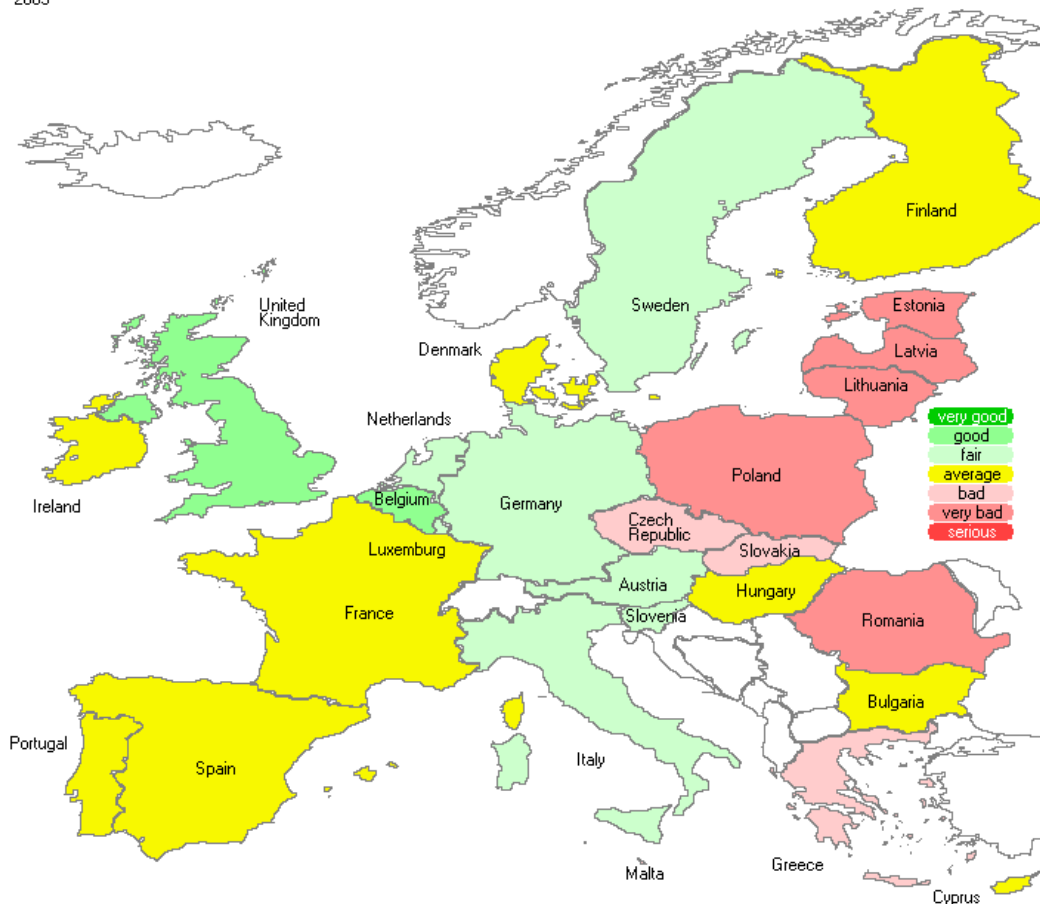


Figure 10 Ranking performance of the Economic Transport Sustainability Index.

The indexed ranking for the economic dimension of sustainable transport performance is presented in Figures 10 and 11. These figures show that the best economic sustainability performance value has been obtained by Belgium and the lowest one by Lithuania. However, the reasons for these ranking results may be better explained by analysing the composite individual sub-indicators in EU Member States.

## Index Economy

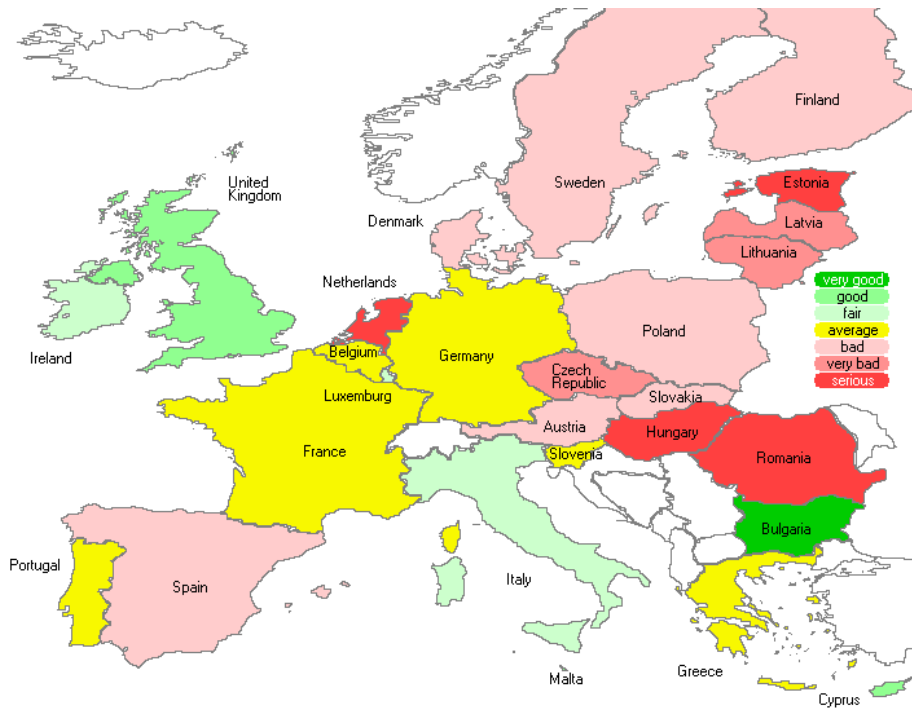
2005



**Figure 11 Economic transport sustainability performance in the EU in 2005 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 4.2.1 Transport Demand and Intensity

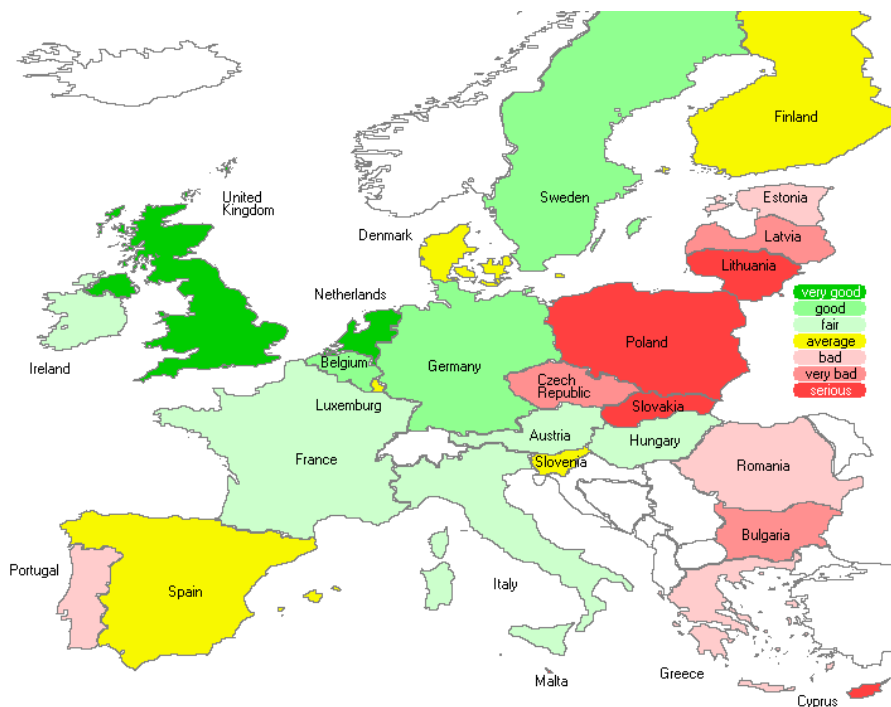
Within the economic dimension of transport sustainability we present the indicator of *Transport Demand and Intensity*. It takes into account transport volume and transport modes focusing on road transport, railway, inland waterways transport as well as air and maritime transport (intra-EU only) (as shown in Figure 9). These indicators include also passenger and freight transport distribution data. The composite indicator of transport demand and intensity reveals the highest sustainability performance for Bulgaria, while the Netherlands rank lowest (Figure 12). As it can be observed from the Figure 12, transport intensity is quite high in Western and Central EU States (especially in Sweden, Finland, the Baltic States, Poland, the Czech Republic, Hungary and Romania), suggesting high loads of transport passing through this specific area. This may be economically beneficial but not very sustainable in terms of increased air pollution, infrastructure use, as well as in terms of health and transport accident risks.



**Figure 12 Sustainability Performance in the EU in Terms of Transport Demand and Intensity**

#### 4.2.2 Transport Costs

The second indicator within the economic dimension of transport sustainability is the indicator of *Transport Costs*. It focuses on transport taxes and prices, investment in infrastructure, fuel taxes and prices, transport user costs and etc. (Figure 9). The ranking of the EU Member States calculated on the basis of transport costs data reveals that the United Kingdom scores the highest performance value, while Lithuania has the lowest ranking score (Figure 13). From this figure it is clear that the Western EU States have higher performance in comparison to the Eastern EU Members in terms of transport costs. Although currently transport sustainability policies focus on the issue of decoupling transport from economic growth, the results of ranking based on transport costs reveal significant difference between the new EU-12 States and the older EU-15 countries, revealing a close link between transport and economy. Compared to the New EU Member States better economic standard in the EU15 results in higher road infrastructure investments, financed through higher fuel taxation. Higher fuel prices also strengthen the competitiveness and density of public transport. Higher wealth and taxation combined have a positive impact on the overall cost and performance of transport.



**Figure 13 Sustainability Performance in the EU in terms of Transport Costs (green color denotes high sustainability performance, yellow- medium and red - low performance).**

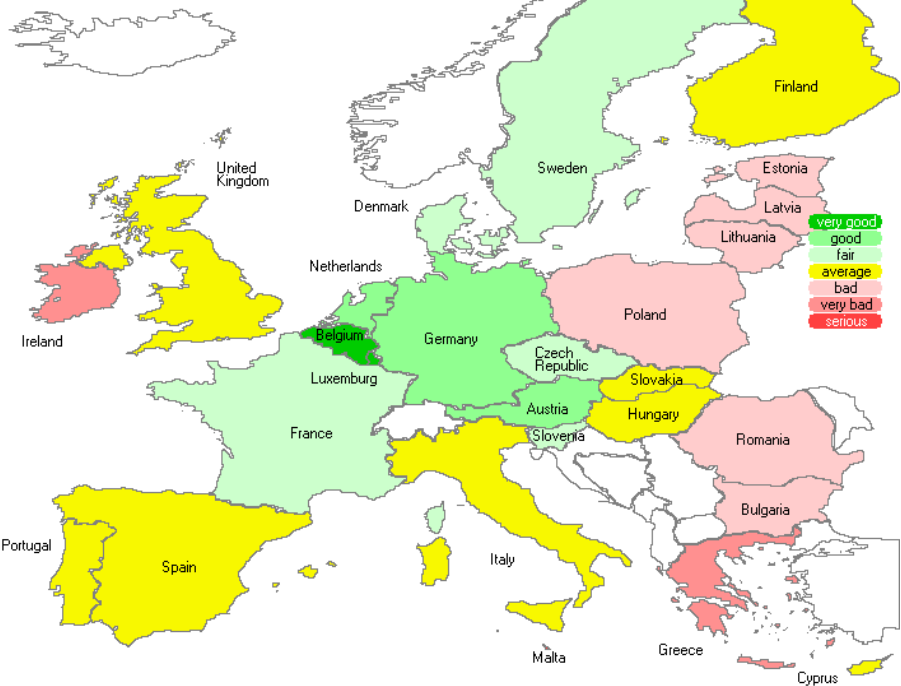
#### 4.2.3 Infrastructure

The last component of the economic transport sustainability dimension within the *JRC SusTrans Index* deals with the *infrastructure* issue. The infrastructure indicator takes into account such information as road length and density, as well as railway length and density. On one hand higher road length and density is a positive factor as it allows for better transport connections and lower congestion. On the other hand, high road density may have negative impacts on environment. We are aware of this is contradictory issue, however as the indicator of infrastructure belongs to economic dimension in our indicator framework, this indicator is assessed in terms of economic performance. On the basis of the available data it was calculated that in terms of infrastructure Luxembourg has the highest performance score, while the lowest performance is observed in Malta (Figure 14).

Similarly to the previous two economic indicators discussed earlier, the indicator of infrastructure indicates higher sustainability performance in the Western EU Member States compared to the Eastern ones. In fact, the Western European States (Germany, Austria, Belgium, Netherlands etc.) have the highest length and density of infrastructure activities.

In Europe infrastructure, especially of road and high- speed rail, continues to expand (EEA, 2004). This indicator, as many other transport sustainability indicators, poses a strong challenge, whether it is good or bad to have transport infrastructure expanding. From an economic point of view, one may consider this indicator as positive, since increasing, or rather: improving, transport infrastructure positively contributes to accessibility and capacity of transport. However, construction of new transport infrastructure may cause habitat fragmentation, and may result in transport increase which significantly contributes to deterioration of air quality and increase of noise. As one example of economically optimal solution would be to further increase the *variable* costs of transport through higher fuel taxes, while using the added revenue to lower the *fixed* costs of transport. Another possible

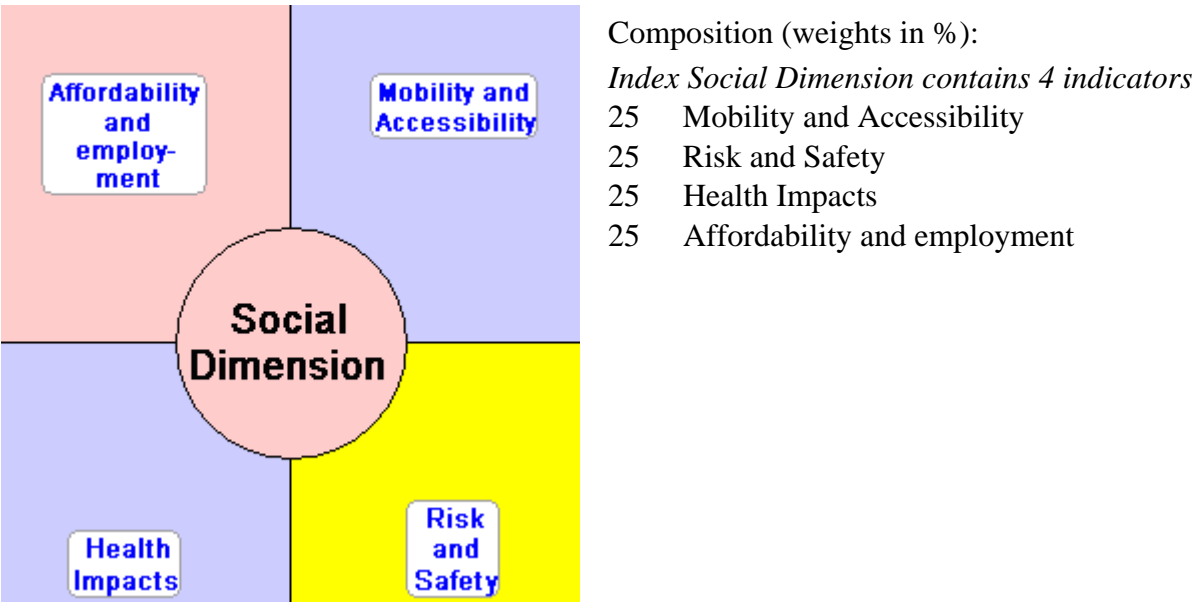
way would be to introduce road pricing and congestion charges which in specific situations (e.g. inside urban agglomerations) may help to resolve the situation in more efficient ways (ECMT, 2003).



**Figure 14 Sustainability Performance in terms of Infrastructure in the EU (green color denotes high sustainability performance, yellow- medium and red - low performance).**

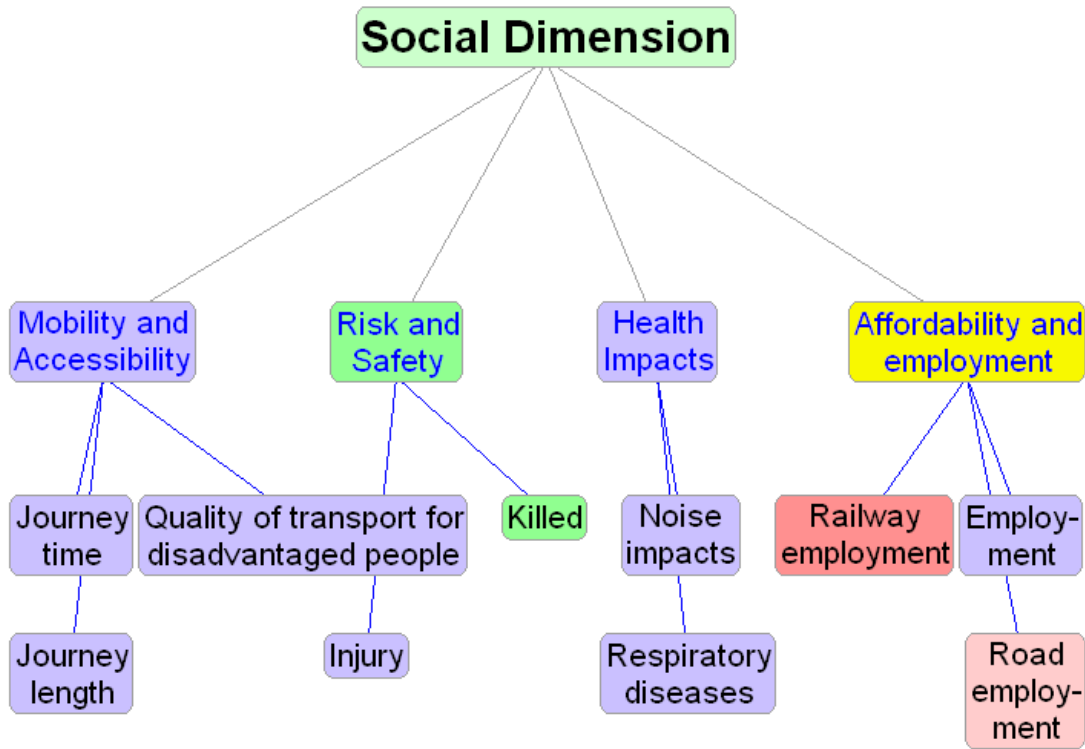
### 4.3 Social Transport Sustainability Performance

The structure of the *social transport sustainability* dimension focuses on four major components, which are *affordability, mobility & accessibility, health impacts and risk & safety*. As shown in the Figure 15, the weights of indicators are equal. Due to the lack of data for the indicator of health impacts, in this report we focus on the remaining three major components. The issue of health impacts is not addressed in quantitative terms due to unavailability of specific data relating to noise impacts on health and transport-related respiratory diseases. The indicator of mobility is presented in quantitative terms and discussed in this report, however, it is not included into the overall calculation of social transport sustainability index due to its contradictory nature (explained in the paragraphs below).



**Figure 15 Structure of the Social Transport Sustainability Index.**

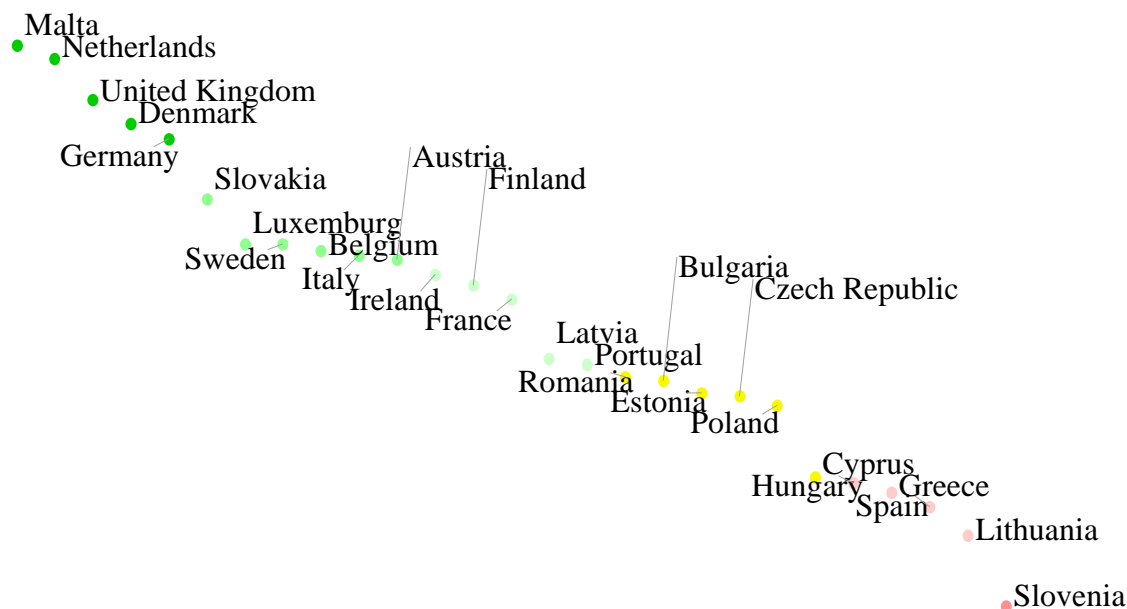




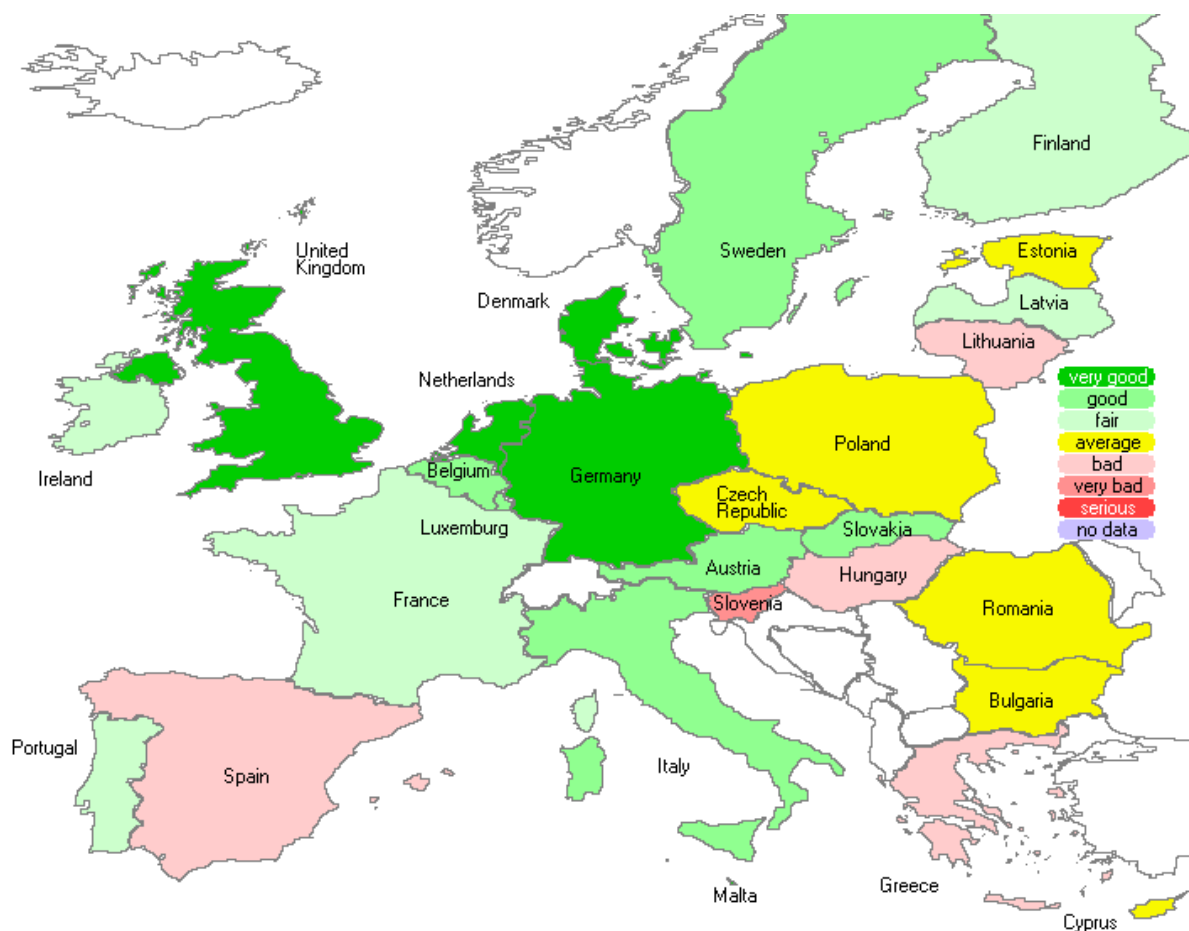
**Figure 16 Structure of the Social Transport Sustainability Index.**

Figure 16 shows the overall detailed structure of the *Social Transport Sustainability Index*. As it is mentioned earlier, not all the composite indicators of social transport sustainability index are addressed in quantitative terms mainly due to the lack of data. In terms of mobility and accessibility we have introduced the indicator proxy called *trends in the share of transport in household expenditures*. However, we have not included this indicator into the overall calculations due to its contradictory nature. For the second indicator of social transport sustainability which deals with the issue of risk and safety, we have analyzed the *numbers of road traffic accidents*. In terms of affordability, we have looked at the *employment in transport sector*.

According to our calculations, the best social sustainability performance of transport activities has been observed in Malta, while the lowest social transport sustainability performance is in Slovenia (Figure 17 and Figure 18).



**Figure 17 Ranking of the EU Member States according to the Social Transport Sustainability Performance Scores.**

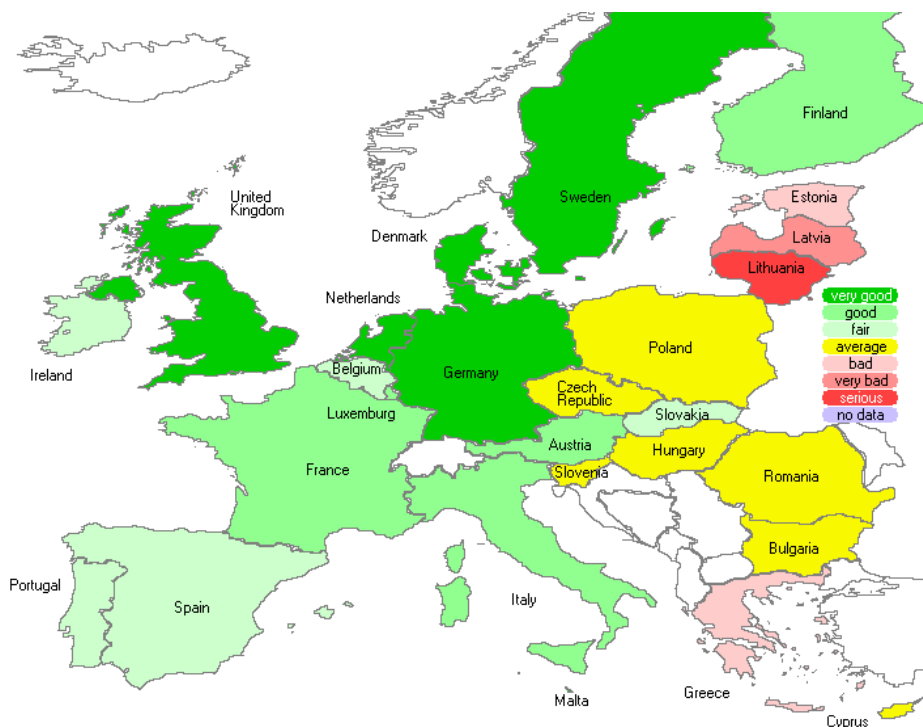


**Figure 18 Social Transport Sustainability Performance in the EU (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 4.3.1 Risk and Safety

As a starting point of social transport sustainability dimension we begin to analyze the indicator of risk and safety, which is represented by the sub-indicator *road accidents* and reflects a significant issue of transport sustainability. According to our calculations, the honour of best performance of transport activities in terms of low road accident rates has been awarded to Malta, while the highest road transport accident rates in 2005 were observed in Lithuania (Figure 19).

From Figure 19 it can be observed that in the Baltic States the situation is most critical regarding road accident rates. In general, the highest number of car accidents is observed in the new Member States of the European Union (EU-12), mainly due to old vehicles, poor roads and bad driving habits. The number of cars has increased rapidly while infrastructure was unable to deal with the higher volume of traffic (Barrot, 2006). The situation is being currently addressed in these countries by harmonization of speed limits, increasing traffic control and stricter penalties to drivers, improvement of the infrastructure network quality and more efficient application of car safety measures (e.g. compulsory safety belt use and limited driving hours for lorry drivers). Moreover, the EC measures include reaching the target of halving the number of killed on EU roads between 2001 and 2010. However, up to 2006 the European Union's yearly reduction in road deaths on average is only 4.9%. In order to half road deaths between 2001 and 2010 an annual reduction of at least 7.4% is needed (ETSC, 2006).



**Figure 19 Sustainability Performance in the EU27 on the basis of the Risk and Safety Indicator**

### 4.3.2 Sustainable Mobility

Currently the issue of mobility in the EU raises many discussions among various types of stakeholders. The mid-term review of EC (2006) called “Keep Europe moving: a transport policy for sustainable mobility” emphasizes that mobility is essential for Europe’s prosperity and for free movement of citizens. Aiming to improve the functioning of the transportation system in Europe in terms of energy saving and higher environmental quality, this mid-term review focuses on a freight logistics action plan, intelligent transport systems to make mobility greener and more efficient, to improve mobility in urban areas, to boost inland waterways and foster green power in trucks and cars. More importance is

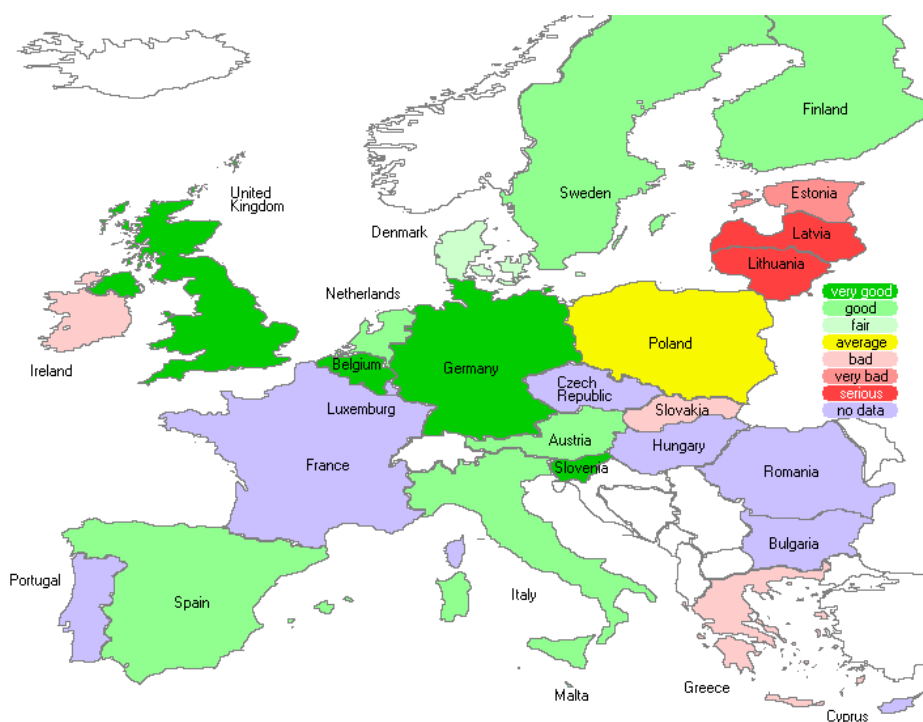
given to the creation of better synergies between road, sea, rail and inland waterways by integration integrating transport modes and infrastructures.

The indicator of personal mobility is presented in our report, but as explained previously, it is not included in the final calculation of the *SusTrans Index*. In this study personal mobility indicator is represented by the indicator of *trends in the share of transport in household expenditures*.

This share of transport in household expenditures may raise contrasting information. If we consider as share of transport in household expenditures only the part spent in public transport, the trend towards lower values would mean positive sustainability performance: This would indicate that everybody, including children, poor, handicapped and others who cannot drive a private car, has good and low-cost access to public transport. An increase of the indicator means lower mobility (lower access to public transport, and the need to organise and pay private transport). However, if the share of transport in household expenditures is dedicated to private transport, the meaning becomes completely different. The lower cost used for private transport means unsustainable transport trends. This implies more intensive car use with the consequent impact in the environment. Due to this contradictory difference and our inability to differentiate between the public and private transport share in household expenditures we did not include this indicator in the calculation of the overall *SusTrans Index*.

Moreover, if we consider the issue of different social income groups (not taking into consideration private and public transport), retired people for example spend less on transport as do unemployed (EEA, 2004). If the share of income allocated to transport is constant for the different groups in society, increasing the prices (internalization) becomes a useful tool for governments to influence transport volumes (EEA, 2004).

Figure 20 reveals that the best mobility performance is in the UK and the lowest one in Latvia. In general, Germany, Belgium and Slovenia have relatively high transport mobility performance, while the Baltic States have low transport mobility performance.



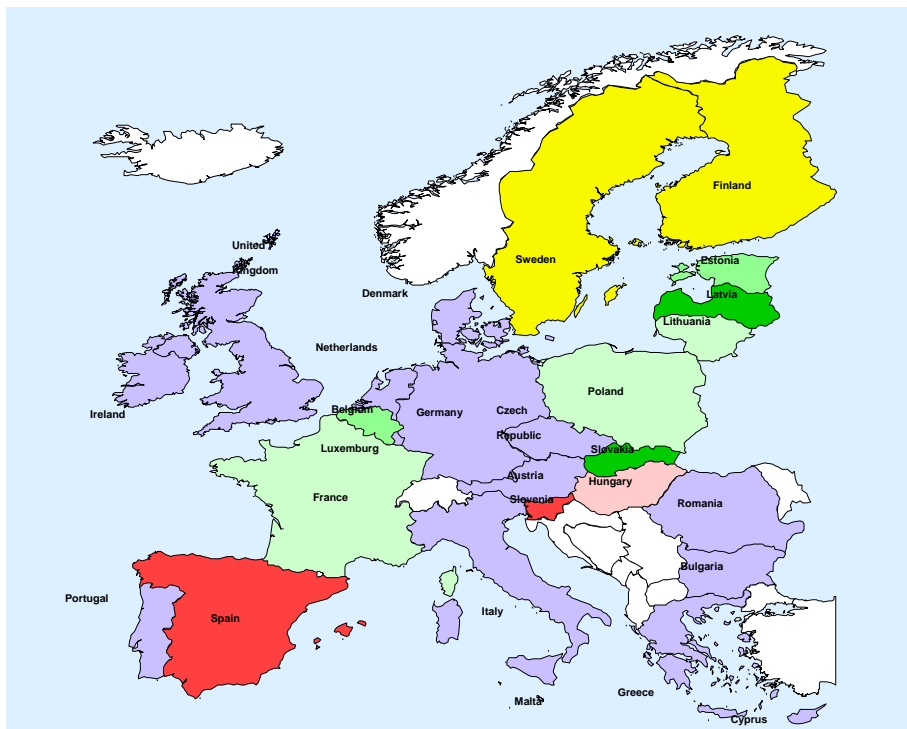
**Figure 20 Sustainability Performance in the EU in terms of Transport Mobility**

### 4.3.3 Employment in Transport Sector

In our originally proposed indicator framework the indicator contribution of transport sector to employment growth has been included. Since quantitative data was not available for this specific indicator, we have used the proxy (as shown in Table 2) represented by indicator of employment in transport sector.

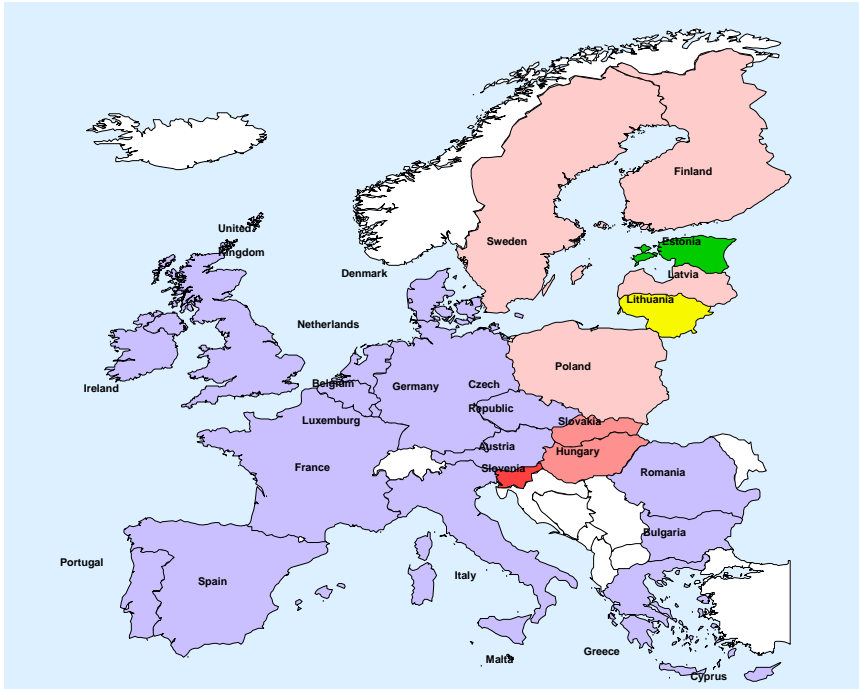
Employment in transport sector is an important issue of social transport sustainability dimension. In general, employment is the theme of social equity and it is one of principal values underlying sustainable development with people and their quality of life being recognized as a central issue (UNDP, 2003). Transport sector employs more than 9 % of the entire EU workforce, generating a turnover amounting to 20% of the Unions GDP (ERF, 2005). Road transport accounts for slightly more than 50% of all persons employed in the transport sector. In recent years shifts between modes have been observed: the rail sector employs fewer people than it previously did, whereas employment tends to increase in road transport sector (EC, 2009).

In our study employment in transport sector takes into account employment only in road and rail transport sectors. This is because these two data sets were the most complete and the data on employment in other transport modes in the EU were unavailable to the authors.



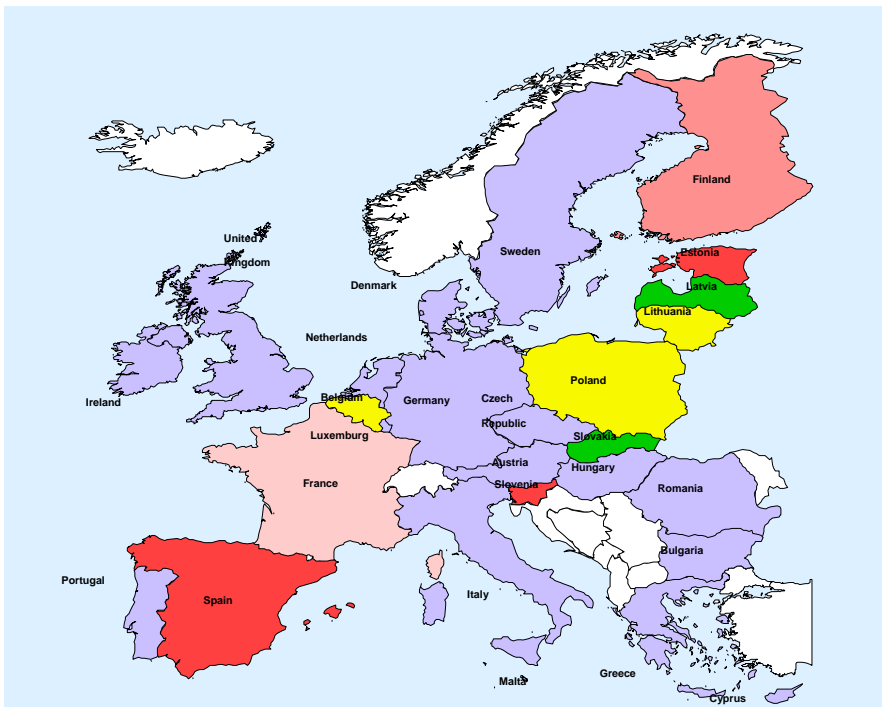
**Figure 21 Sustainability Performance in the EU in terms of Employment in Transport Sector (green color denotes high sustainability performance, yellow- medium and red - low performance).**

Figure 21 shows the highest employment in transport sector in the EU is in Latvia and the lowest one- in Slovenia. In order to get more precise information on transport employment situation we also present the maps of employment performance in road transport sector and in railways sector.



**Figure 22 Sustainability Performance in the EU in terms of Employment in Road Transport Sector (green color denotes high sustainability performance, yellow- medium and red - low performance).**

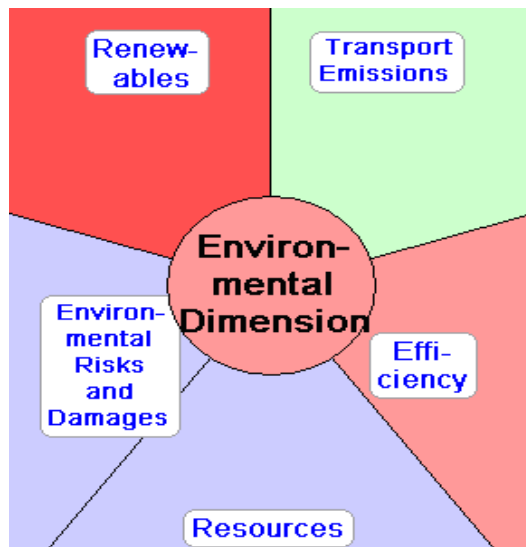
In Figure 22, employment in road transport sector is the highest in Estonia and the lowest in Slovenia. Employment in railways transport sector shows quite a different situation, where the highest employment performance in Slovakia and the lowest one is in Estonia.



**Figure 23 Sustainability Performance in the EU in terms of Employment in Railways Transport Sector (green color denotes high sustainability performance, yellow- medium and red - low performance).**

#### 4.4 Environmental Transport Sustainability Performance

The structure of the *Environmental Transport Sustainability Index* is presented in Figure 24 and Figure 25. Five different components are taken into account for assessing environmental sustainability performance of transport activities. These are as follows: *transport emissions*, *energy efficiency*, *use of resources*, *environmental risks and damages* as well as the *use of renewable resources in transport sector*. As indicated in Figure 24 environmental dimension of the *SusTrans Index* is calculated using the equal weight distribution method. However, not all the components of the environmental transport sustainability dimension have been addressed in quantitative terms in our study. Due to the lack of quantitative data, the aspect of environmental risks and damages as well as the use of resources for transport sector has not been addressed. We have analyzed the indicators of transport emissions, energy efficiency and transport renewables indicator - as this quantitative data was available.

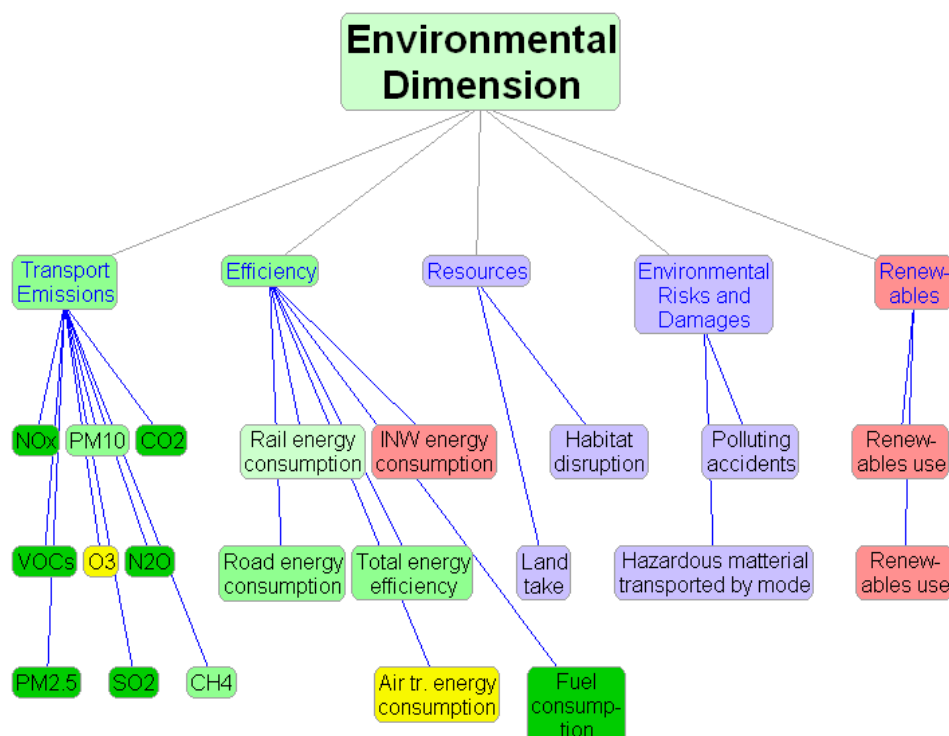


Composition (weights in %):

*Environmental Dimension contains 5 indicators*

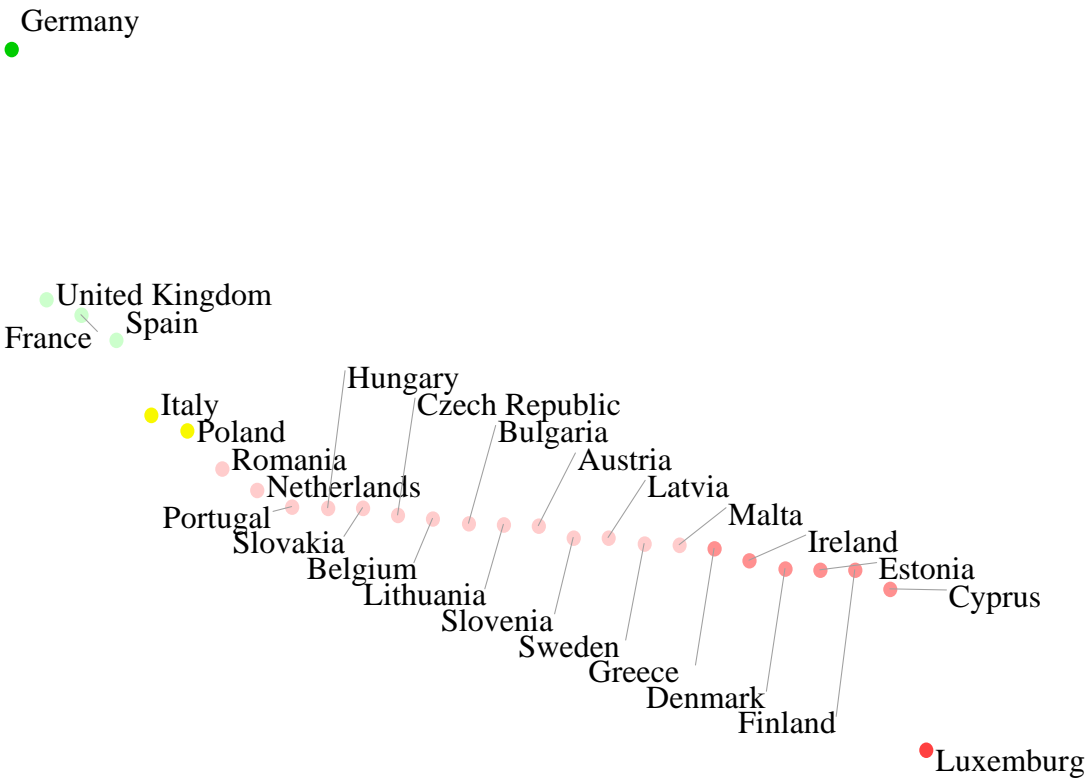
- 20 Transport Emissions
- 20 Efficiency
- 20 Resources
- 20 Environmental Risks and Damages
- 20 Renewables

**Figure 24 Composition of the Environmental Transport Sustainability Index**



**Figure 25 Structure of the Environmental Transport Sustainability Index (data for France 2005)**

The ranking of the EU27 on the basis of the environmental transport sustainability performance indicates that the best overall value is obtained by Germany, while the lowest value is in Luxemburg (Figures 26 and 27).

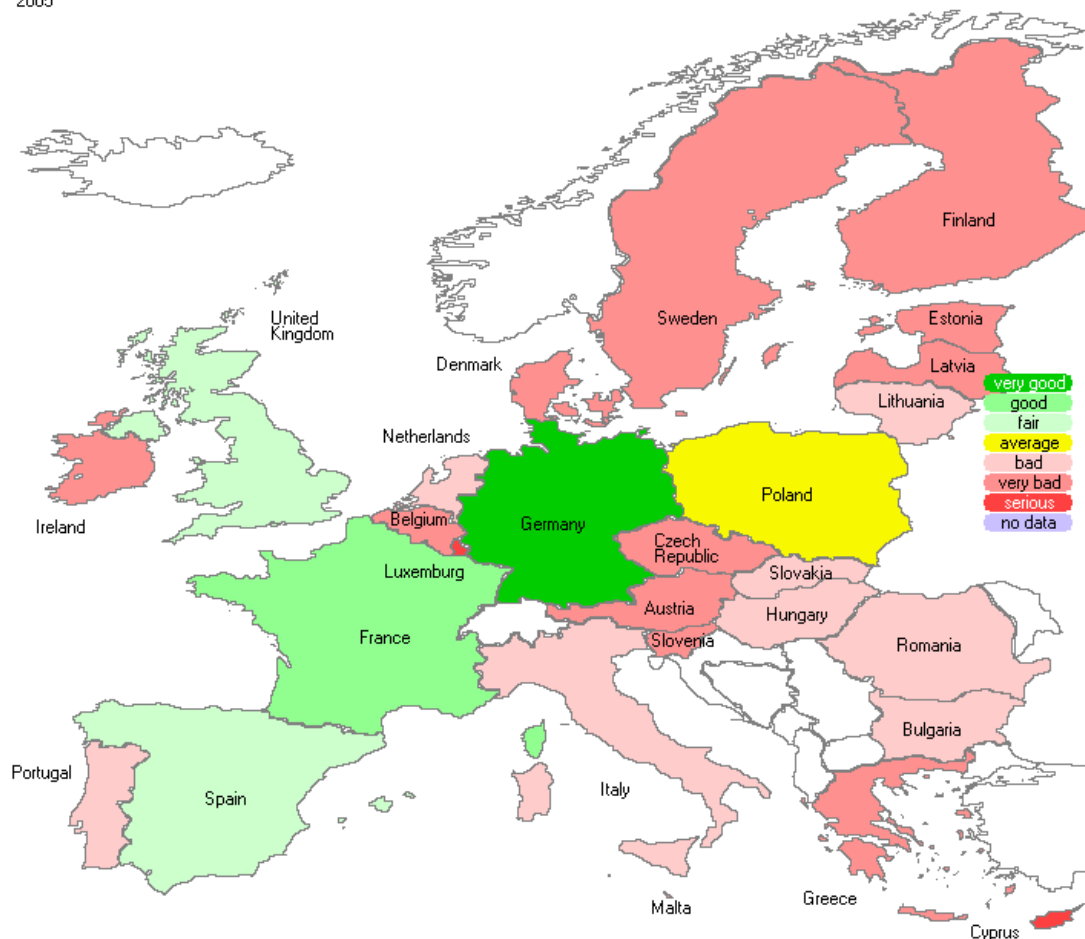


**Figure 26 Ranking of the EU Member States in terms of Environmental Sustainability Performance of Transport Activities.**



## Index Environmental Dimension

2005



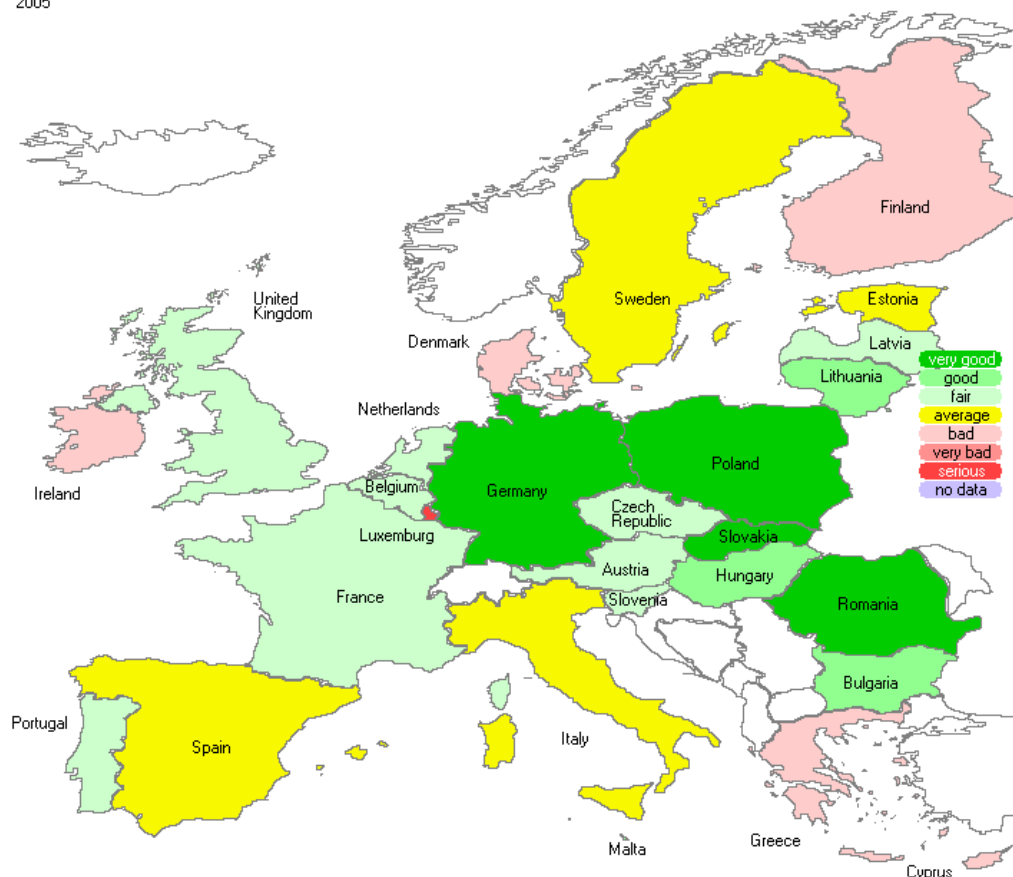
**Figure 27 Environmental Transport Sustainability Performance in the EU 27 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 4.4.1 Transport Emissions

Transport emissions indicator is the crucial part of the environmental dimension related to transport activities as transport sector, in general, is among the top three air pollution sources (EEA, 2004).

## Sub-index Transport Emissions

2005



**Figure 28 Distribution of Transport Emissions in the EU Member States.**

As shown in Figure 25 we focus on the following emissions originating from transport sector: NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO<sub>2</sub>, VOCs, emissions of O<sub>3</sub> precursors, N<sub>2</sub>O, CH<sub>4</sub>, SO<sub>2</sub>. All these emissions are of significant importance in terms of transport activities. Especially PM, NO<sub>x</sub> and CO<sub>2</sub> are of high importance, as transport results to be among the major contributors compared to other industrial sectors (EC, 2006).

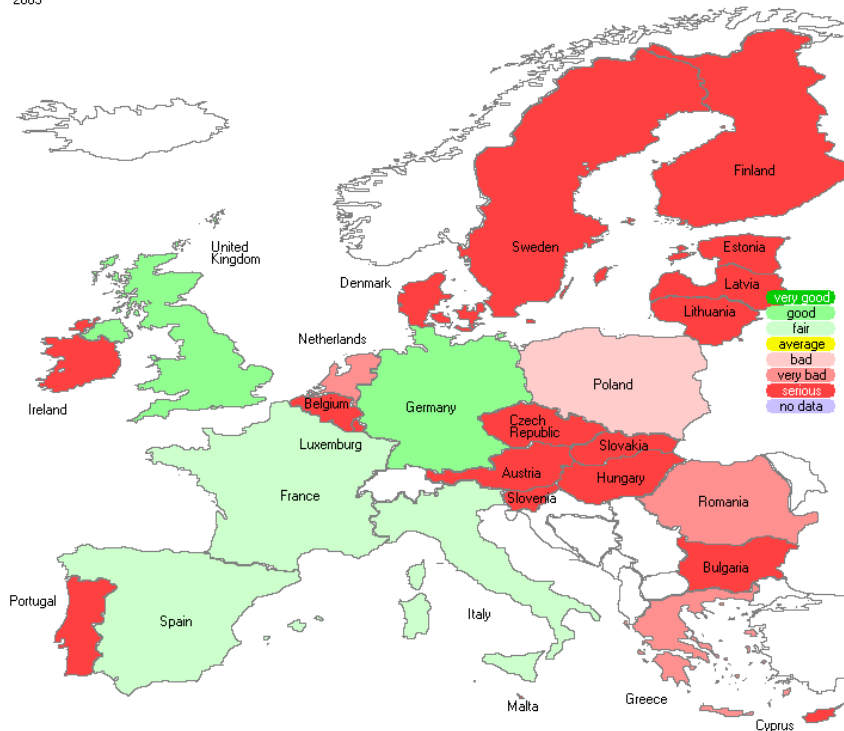
In terms of transport emissions, the best transport sustainability performance score is obtained by Germany and the lowest one – by Luxembourg. Figure 28 shows the distribution of transport emissions in the EU Member States. From the map it can be observed that the overall situation regarding transport emissions in 2005 is not extremely critical. The older EU Member States, in particular Italy, Greece, Spain as well as Sweden, Finland, Denmark have more emissions from transport activities compared to the New Members of the EU and some central European Union countries. However, the situation may be interpreted better once we analyze each pollutant in detail. This we have done in the presentation of the *EEA TERM Transport Sustainability Index* (in Chapter 5). The EEA (2004) report supports our finding that transport emissions in the EU show decrease of environmental pollution in spite of traffic growth (EEA, 2004). This is mainly due to the improvement in transport technology which nowadays more efficiently meets European emission (EURO) standards. Moreover, new EU initiatives are set to strengthen the control of traffic emissions, especially NO<sub>x</sub> and emissions of fine particles (EEA, 2004; EC, 2009). However, the situation regarding the CO<sub>2</sub> emissions is less optimistic, due to increase of traffic volumes greenhouse gas emissions are growing, especially due to aviation (EC, 2009).

#### 4.4.2 Transport Energy Efficiency

The second component of environmental transport sustainability dimension presented in our study is *energy efficiency*. As discussed in the documents of the EEA (2004; 2006) transport energy consumption is increasing steadily. Transport now accounts for about 35 % of energy consumption in the EU. Our indicator of transport energy efficiency includes the issues of *energy consumption by transport mode*, *total energy efficiency* as well as *fuel consumption in road transport sector*. The outcomes of our data reveal that in terms of energy efficiency the best sustainability performance is obtained by the United Kingdom and the lowest one by Malta (Figure 29). The worst transport energy efficiency performance is in general observed in the North of the EU and the Central Eastern EU Member States.

##### Sub-index Efficiency

2005



**Figure 29 Sustainability Performance in the EU in terms of Transport Energy Efficiency.**

As stated in the EEA (2004, 2006) publications, energy consumption has increased in most of the EU countries. In terms of transport energy efficiency as seen also from our indicator data, the situation is very critical in the New EU Member States (EU-12). In some of these countries transport energy consumption is still below the level of 1990, mainly due to the economic collapse in the early 1990 (EEA, 2004). Total energy consumption is rising and the fuel efficiency of cars depends on the technology on board, air and tire resistance, and the weight of the vehicle (EEA, 2004). Some countries like Austria, Denmark, France, Hungary and the UK have implemented differentiated registration and ownership taxes that encourage fuel- efficient cars.

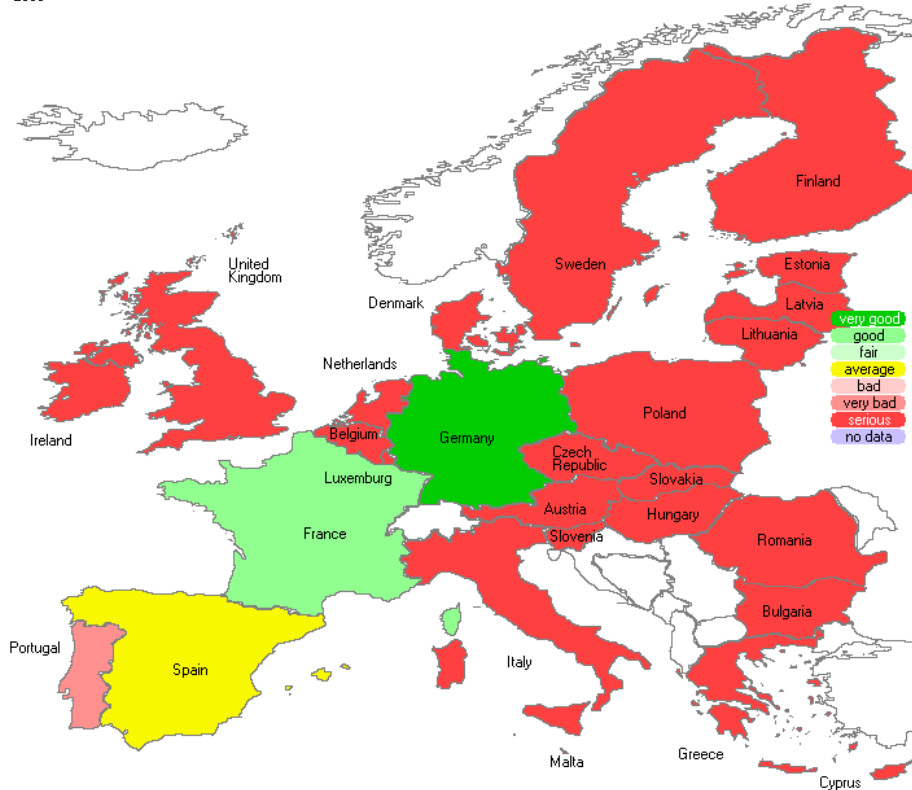
#### 4.4.3 Renewables in Transport Sector

In the EU Member States the policies regarding alternative fuels are starting to exert effects with biofuels. In transport sector increasing use of biofuels is projected to help reducing transport emissions of greenhouse gases. However, application of biofuels is still a compromising issue in transport sector as the production of biofuels involves some negative environmental impacts. Significant agricultural areas devoted to the production of biofuels (e.g. rapeseed, sunflower, wheat, sugar beet, etc.) may negatively impact biodiversity and landscape (EEA, 2004). Currently alternative EU policies of transport fuels aim at replacing diesel and gasoline with other possible fuels which have lower amount of air emissions (e.g. hydrogen, etc.). Moreover, in terms of renewables in transport the ambitious

goals of the European Council in 2007 include the 20/20/20 package, which aims to increase the share of renewable resources in its energy mix to 20% by 2020, and to improve its energy efficiency by 20% by the same date (EC, 2009).

### Sub-index Renewables

2005

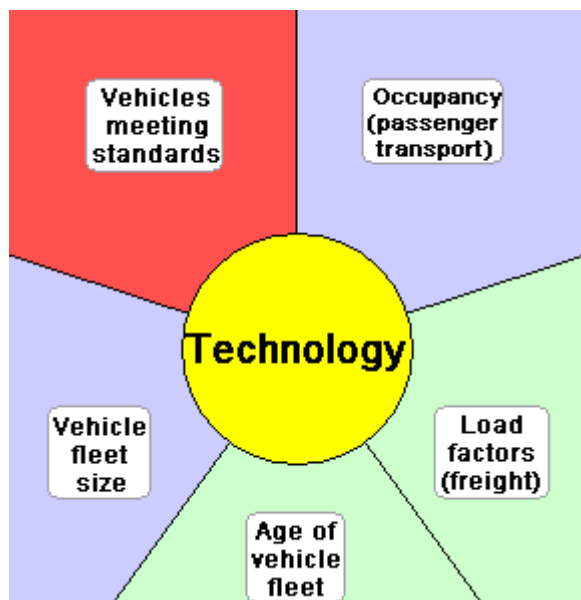


**Figure 30 The Use of Renewables in Transport Sector in the EU27.**

In terms of use of renewable sources in transport activities the best performance value has been obtained in Germany, and the lowest performance score by United Kingdom (Figure 30). This result suggests that Germany is more advanced in terms of exploring renewable sources in transport sector. Thus, it is also one of the reasons why it has the best sustainability performance in the EU. In terms of use of renewable resources in Europe the situation is critical (see Figure 30). This is also due to the fact that the issue of using renewable resources (especially biofuels) is controversial. It involves a lot of discussions among various stakeholders and decision-policy makers whether the production and the use of biofuels is environmentally friendly. Another obstacle limiting deeper analysis of the use of renewable resources in transport is lack of reliable quantitative data.

## 4.5 Technical/ Operational Transport Sustainability Performance

The structure of the *Technical/ Operational Transport Sustainability Index* (Figure 31 and Figure 32) focuses on 5 different indicators, namely *occupancy rate of passenger vehicles*, *cross-trade road goods transport performer by haulers*, *average age of vehicle fleet*, *size of vehicle fleet*, *ration between passenger car new registrations and the passenger car fleet* (which in our study denotes cars meeting environmental/ technical standards). However, due to the lack of corresponding data in our report, the indicator dealing with occupancy rate of passenger vehicles is not analysed in quantitative terms and thus it is also not included into the overall *SusTrans Index* calculation. While occupancy rate (load factor) of heavy duty vehicles (HDV) is analysed in this report and is represented by the proxy indicator of *cross-trade road goods transport performed by haulers*. This indicator indicates the amount of heavy duty vehicles which carry goods for the purpose of trade. Although it is not exactly the same as the originally proposed indicator of occupancy rate of heavy duty vehicles, this proxy indicator in a similar way deals with HDV vehicles taking into account their load factors.

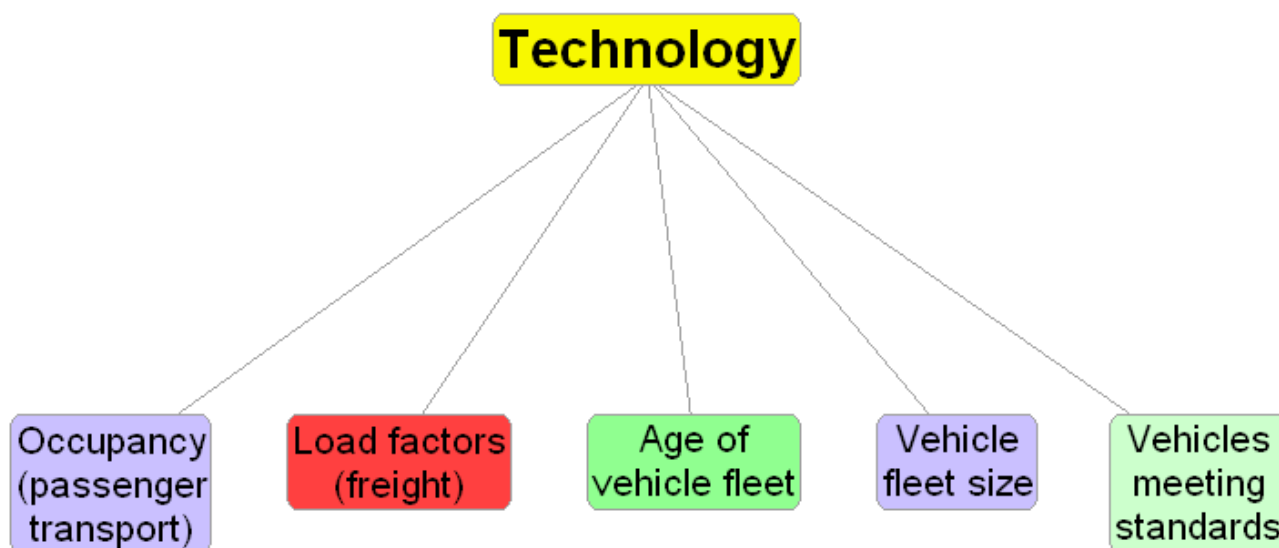


Composition (weights in %):

*Index Technology contains 5 indicators*

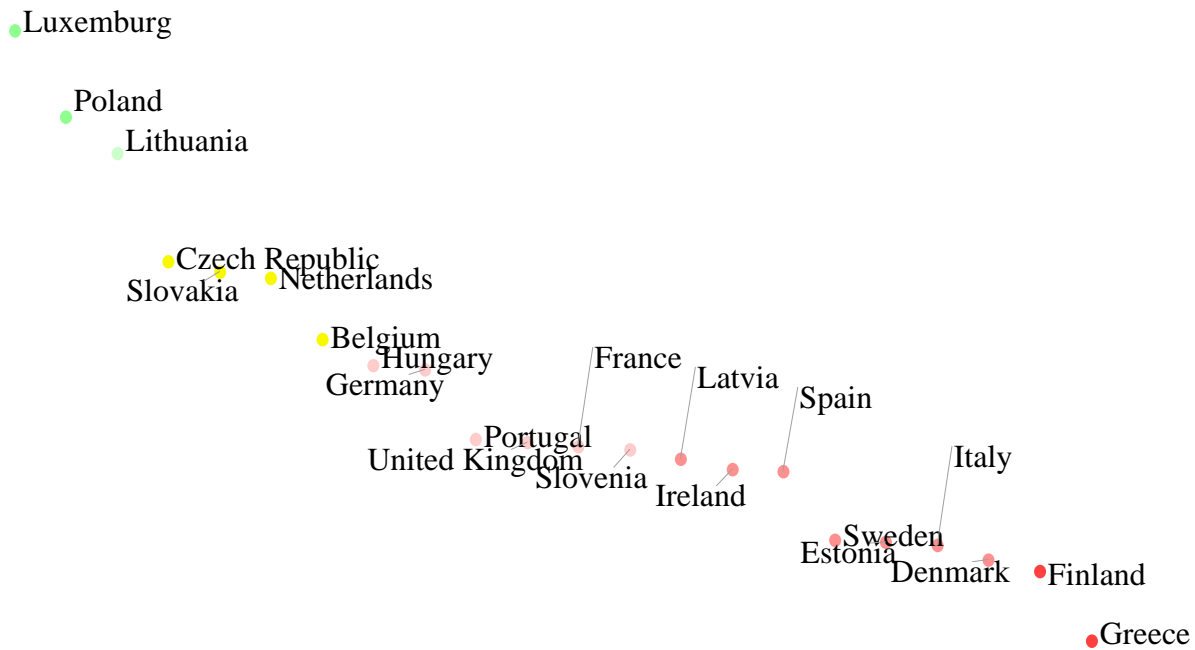
- 20 Occupancy rate of passenger vehicles
- 20 Cross-trade road goods transport performed by haulers
- 20 Average age of vehicle fleet
- 20 Size of vehicle fleet
- 20 Ratio between passenger car new registrations and the passenger car fleet

**Figure 31 Composition of the Technical/ Operational Transport Sustainability Index.**



**Figure 32 Composition of Technical/operational Transport Sustainability Index.**

On the basis of our calculations performed by the Dashboard tool, among the EU Member States Luxembourg has the best performance score in terms of technical/operational transport sustainability dimension, while Greece has the lowest score in this context (Figure 33 and Figure 34). As it can be observed from the EU map (Figure 34), the situation in terms of technical/operational transport sustainability performance is very critical in the Baltic States and Finland, followed by Italy. In order to better understand the technical/operational transport sustainability performance in the EU Member States, the sub-sections below analyze the composite indicators of technical/operational transport dimension.



**Figure 33 EU Member States Ranking According to the Technical/ Operational Transport Sustainability Index.**



**Figure 34 Sustainability Performance in the EU in terms of Technical/Operational Transport Sustainability (green color denotes high sustainability performance, yellow- medium and red - low performance).**

#### 4.5.1 Heavy Duty Vehicles Occupancy

One of the comprising indicators of technical/operational dimension is *cross-trade road goods transport performed by haulers*. Figure 35 shows the ranking of the EU 27 indicating that Poland has the highest occupancy (load factor) of heavy duty vehicles and Finland the lowest one. Although in our study high load factor of heavy duty vehicles has been considered as a positive factor in terms of sustainability, this indicator may have also an opposite judgment. On one hand, high occupancy of heavy duty vehicles may be positive in terms of lower traffic congestion, reduced use of fuels and at the same time lower transport emissions. On the other hand, high loads of heavy duty vehicles may be harmful for quality of infrastructure. Consequently, poor road quality can be a factor of high risk in terms of traffic safety.



**Figure 35 Sustainability Performance in terms of Occupancy of Heavy Duty Vehicles in the EU27 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

The EC transport strategies currently promote using fewer and bigger vehicles, meaning fewer trips with fuller vehicles, hoping that this would have positive outcomes on both environmental savings for society and economic savings for companies (EEA, 2009).

#### 4.5.2 Vehicle Fleet Age

Another important indicator within the technical-operational dimension of transport sustainability is the indicator of *Average Age of Vehicle Fleet*. The age of vehicle fleet in general reflects the economic status of the country, thus it is interesting to observe whether this is true for the results that we have obtained from analyzing our indicator data.

In terms of vehicle fleet age, the best sustainability performance rank is obtained by Luxemburg and the lowest performance is observed in Greece (Figure 36). From the Figure 36 it can be observed that relatively low performance in terms of vehicle age is also in Spain, Italy, Germany, Sweden and Finland. However, unfortunately quantitative data is missing for most of the New EU Member States, where the situation is expected to be the most critical. Transitional economic situation in the new EU Member States has influenced the growth of older vehicle fleet. It is expected that with economic growth and increasingly stricter environmental standards also the vehicle fleet in the new EU Member Countries will eventually become newer and cleaner.

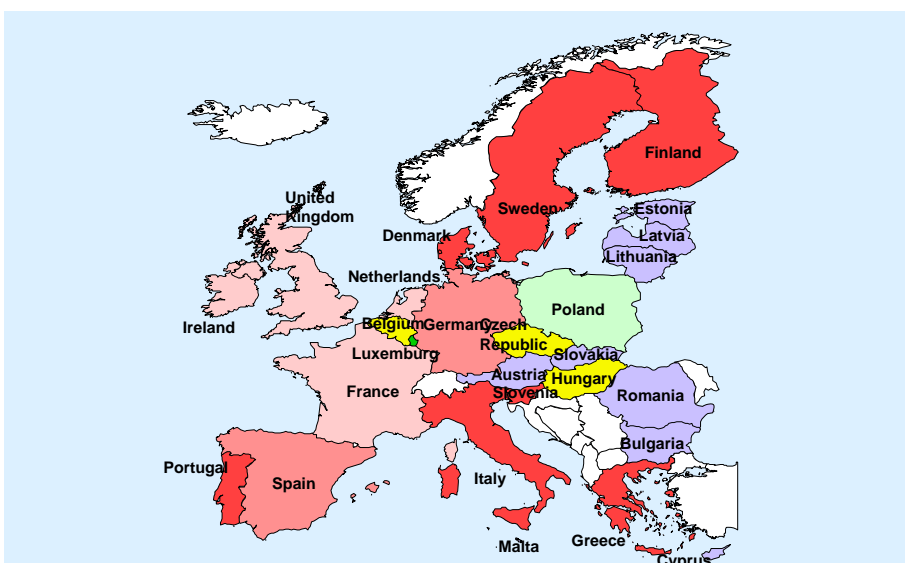




**Figure 36 Sustainability Performance of the EU 27 in terms of Vehicle Fleet Age (green color denotes high sustainability performance, yellow- medium and red - low performance).**

#### 4.5.3 Vehicles meeting Environmental-Technical Standards

The indicator titled the *Ratio between Passenger Car New Registrations and the Passenger Car Fleet* is an indicator proxy and indicates how efficiently the passenger cars are meeting environmental-technical standards. As this indicator proxy in some way is similar to the earlier discussed indicator of vehicle fleet age, in order to avoid a double-counting it is important to outline the difference and additional information provided by this indicator. The previously discussed indicator of vehicle fleet age represents the *average age of vehicle fleet* which is a useful number indicating the general age of the vehicle in the country. While the indicator of ratio between passenger car new registrations and the passenger car fleet provides additional information on how many new vehicles (which are completely compatible with the current environmental and technical standards) are introduced in relation to the existing car fleet.



**Figure 37 Sustainability Performance in the EU in terms of Vehicles Meeting Environmental-Technical Standards (green color denotes high sustainability performance, yellow- medium and red - low performance).**



The best performance value in terms of this indicator is obtained by Luxemburg and the lowest performance - in Finland (Figure 37). From Figure 37 it may be observed that the situation of meeting environmental- technical transport standards is rather critical in the whole EU. Unfortunately, the lack of data does not allow discussing this issue in greater detail. However, it is important to mention, that EU policies regarding the implementation of environmental standards are becoming gradually stricter and this positively influences the progress towards more sustainable transport activities.

#### 4.6 Trends of Transport Sustainability Performance

In this section we discuss the trends of transport sustainability performance during the period from the year 2000 to 2005. Figure 38 below shows how the performance of transport activities has changed during the five year period. Figures below reveal the performance trends in terms of each sustainability dimension.



**Figure 38 The Trend in Change of Transport Sustainability Performance in the EU 27 from 2000 to 2005 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

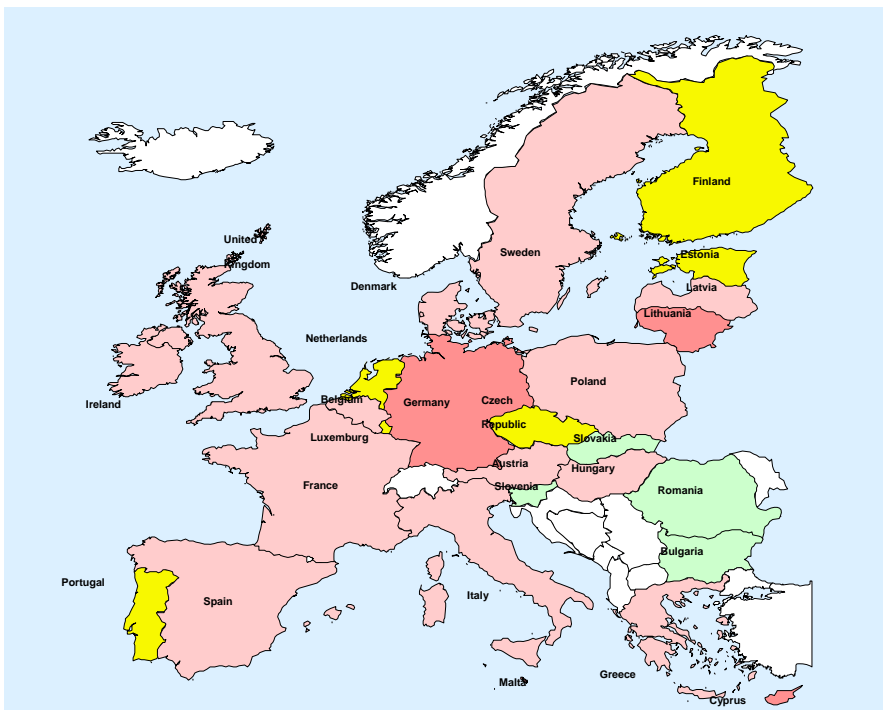
As shown in Figure 38, the Dashboard reveals that the situation from 2000 to 2005 has altered in a medium way in most of the EU Member States. In Germany, Latvia, Portugal and Slovenia- a positive change has been observed, while in Lithuania, Finland, Poland, Hungary and Romania – more critical change in performance of transport sustainability.

In terms of environmental performance the Dashboard tool indicates that during the period from 2000 to 2005 the situation has become more critical in many of the EU States, especially in France and Romania (Figure 39). Green color on the Dashboard map shows that in Germany environmental sustainability performance has improved during this period.



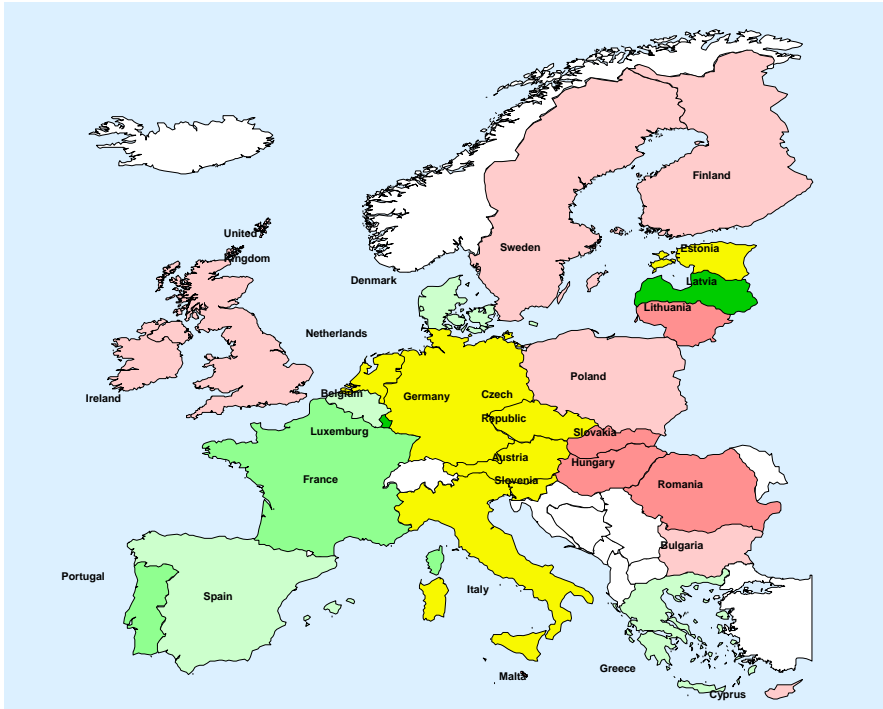
**Figure 39 Trend in Change of Environmental Transport Sustainability Performance in the EU27 during the period from 2000 to 2005 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

According to our calculations, economic transport sustainability performance deteriorated over the period from 2000 to 2005 in a great majority of the EU Member States. Except for Slovakia, Slovenia and Bulgaria economic transport sustainability is indicated as improved (Figure 40).

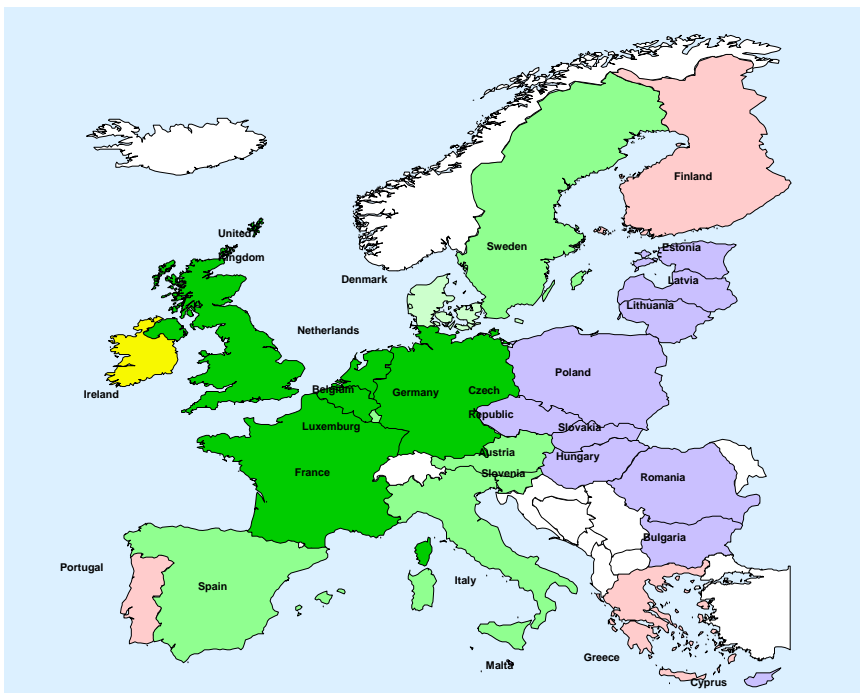


**Figure 40 Trend in Change of Economic Transport Sustainability Performance in the EU27 Member States during the Period from 2000 to 2005 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

Social transport sustainability performance trends indicate that it has been improving over the period of 5 years (from 2000 to 2005) in the Mediterranean Countries of the EU, namely in Portugal, Spain, France, Greece (Figure 41). In the Central EU the trend over 2000 – 2005 in terms of social transport sustainability reveals medium level of progress. In the Eastern and Northern EU Member States the social transport sustainability performance has decreased.



**Figure 41 The Trend in Change of Social Transport Sustainability Performance in the EU27 during the Period from 2000 to 2005 (green color denotes high sustainability performance, yellow- medium and red - low performance).**



**Figure 42 Trend in Change of Technical-Operational Transport Sustainability Performance in the EU 27 during the Period from 2000 to 2005 (green color denotes high sustainability performance, yellow- medium and red - low performance).**

Figure 42 reveals that technical-operational transport sustainability performance in the majority of Western EU Member States has improved suggesting that EU Members efficient implementation of various transport sustainability policies which reflected positively on the technical-operational status of transport sector.

In summary, it can be emphasized that over the five year period transport sustainability performance has become more critical in the EU Member States in terms of economic and environmental dimensions. This observation suggests, that future EU policies should focus on strengthening specifically the economic and environmental aspects of transport. Although transport demand is closely linked to the economic growth, in times of economic slowdown transport has proved to recover more quickly than the rest of the economy. This transport growth resilience is also observed in the times of economic growth where transport grows faster than overall GDP, although this is partly to do with faster growth in international trade (EC, 2009). In spite of this close link between transport and economy, current EU policies focus on the decoupling policy of separating transport growth from the economic growth. Aiming to reduce environmental impacts (e.g. congestion and other side effects of transport) Sustainable Development Strategy of the EU (EC, 2006) fosters the decoupling economic growth and the demand for transport. This also means the shift of transport activities towards more dematerialized economy, e.g. where the need of movement of people and goods is reduced due to the application of e-commerce and tele-working approaches (EC, 2009).

Other key points to take into account in terms of improvement environmental and economic transport sustainability performance is application of full cost accounting. In particular, internalisation of externals costs related to transport activities would be beneficial for the development of sustainable transportations systems in the EU: such new pricing structures would result in fair pricing (the transport users paying for the burden) and in a modal shift towards more sustainable transportation means (EEA, 2004).

## 5 BENCHMARKING TRANSPORT SUSTAINABILITY PERFORMANCE: THE EEA TERM INDEX

In our study we decided to study also the EEA's Transport and Environment Reporting Mechanism (TERM) indicators. This allowed to benchmark results obtained from the quantitative analysis of the *SusTrans Index* against a different set of indicators. The first part of this section introduces the *EEA TERM* indicators, their quantification sources and structure. Subsequently, the aggregate *TERM Index* has been calculated on the basis of EEA quantitative data. The results are presented and discussed in the whole context of transport sustainability performance of the EU 27 Member States. The analysis of the *EEA TERM Index* results takes into account and compares the outcomes with the results of the *SusTrans Index*.

### 5.1 The EEA TERM Indicators and their Data Sources

The EEA Transport and Environment Reporting Mechanism (TERM) indicators are focused on tracking transport and environment integration in the European Union. As it can be observed from Table 3, all the *EEA TERM* indicators are divided into the two major groups and are composed of various data sources. The first group of *transport and environment performance* includes the components such as environmental consequences of transport, transport demand and intensity. The second group titled *determinants of the transport/ environment system* tackles the components of spatial planning and accessibility, supply of transport infrastructure and services, transport costs and prices, technology and utilization efficiency and management integration. The indicators of the *TERM framework* are originally projected to answer a set of policy questions aiming at more sustainable transport within an enlarged EU (EEA, 2002).

**Table 3.** Transport and Environment Reporting Mechanism (TERM) Indicators and their Data Sources (EEA, 2002).

Indicator theme	Indicator	Data source
<b>1. Transport and Environment Performance</b>		
<b>Environmental consequences of transport</b>	Transport final energy consumption and primary energy consumption, and share in total by mode and by fuel	Eurostat <sup>10</sup> / EIA
	Transport emissions of greenhouse gasses (CO <sub>2</sub> and N <sub>2</sub> O) by mode	ETC <sup>11</sup> / ACC <sup>12</sup>
	Transport emissions for air pollutants (NO <sub>x</sub> , MNVOC <sub>s</sub> , PM <sub>10</sub> , SO <sub>x</sub> , total ozone precursors) by mode	EEA
	Population exposed to exceedances of EU air quality standards for PM <sub>10</sub> , NO <sub>2</sub> , benzene, ozone, lead and CO	ETC/ ACC
	% of population exposed to and annoyed by traffic noise, by noise category and by mode.	EEA
	Fragmentation of ecosystems and habitats/ Proximity of transport infrastructure to designed areas	ETC/TE <sup>13</sup> /NPB <sup>14</sup>
	Land take by transport infrastructure by mode	ETC/TE
	Number of transport accidents, fatalities, injured, and polluting accidents (land, air and maritime)	Eurostat/ UNECE
	Illegal discharges of oil by ships at sea	Bonn agreement and HELCOM <sup>15</sup>
	Accidental discharges of oil by ships at sea	ITOPF <sup>16</sup>
	Waste from road vehicles (end-of-life vehicles)	ETC/ WMF <sup>17</sup>

<sup>10</sup> Statistical Office of the European Union

<sup>11</sup> European Topic Center

<sup>12</sup> Accession country

<sup>13</sup> European Topic Centre on Terrestrial Environment

<sup>14</sup> European Topic Centre on Nature Protection and Biodiversity

<sup>15</sup> Baltic Marine Environment Protection Commission (Helsinki Commission)

<sup>16</sup> International Tanker Owners Pollution Federation

<sup>17</sup> European Topic Centre on Resource and Waste Management

	Waste from road vehicles (number and treatment of used tires)	ETRA <sup>18</sup>
<b>Transport demand and intensity</b>	Passenger transport (by mode and purpose)	Eurostat/ UNECE
	Freight transport (by mode and group of goods)	Eurostat/ UNECE
<b>2. Determinants of the Transport/ Environment System</b>		
<b>Spatial planning and accessibility</b>	Access to basic services: average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and location (urban/ rural)	Various
<b>Supply of transport infrastructure and services</b>	Capacity of transport infrastructure networks, by mode and by type of infrastructure (motorway, national road, municipal road, etc.)	Eurostat/ UNECE
	Investments in transport infrastructure/ per capita and by mode	Eurostat/ ECMT <sup>19</sup>
<b>Transport costs and prices</b>	Real change in passenger transport price by mode	Eurostat
	Fuel prices and taxes	Eurostat/ IEA
	Total amount of external costs by transport mode (freight and passenger); average external cost per passenger-km and tonne-km by transport mode	Infras/ ECMT
	Implementation of internalization instruments i.e. economic policy tools with a direct link with the marginal external costs of the use of different transport modes	Various
	Subsidies	Not available
	Expenditure on personal mobility per person by income group	Eurostat
<b>Technology and utilization efficiency</b>	Overall energy efficiency for passenger and freight transport (per passenger-km and per tonne-km and by mode)	ODYSEE <sup>20</sup>
	Emissions per passenger-km and emissions per tonne-km for CO <sub>2</sub> , NO <sub>x</sub> , NMVOC, PM, SO <sub>x</sub> by mode	ETC/ ACC
	Occupancy rates of passenger vehicles	Eurostat
	Load factors for freight transport (LDV, HDV)	Eurostat
	Uptake of cleaner fuels (unleaded petrol, electric, alternative fuels) and numbers of alternative-fuelled vehicles	Eurostat
	Size of the vehicle fleet	DG TREN <sup>21</sup> / UNECE
	Average age of the vehicle fleet	Eurostat/ REC <sup>22</sup>
	Proportion of vehicle fleet meeting certain air and noise emission standards (by mode)	Eurostat/ REC
<b>Management integration</b>	Number of Member States that have implemented an integrated transport strategy	Various
	Number of Member States with a formalized cooperation between the transport, environment and spatial planning ministries	Various
	Number of Member States with national transport and environment monitoring systems	Various
	Uptake of strategic environmental assessment in the transport sector	Various
	Public awareness and behaviour	Various
	Uptake of environmental management systems by transport companies	EC

The recent report of the EEA (2008) titled “Climate for a transport change” includes the update of *TERM indicators* depending on their data availability for the period from 2000 to 2007. The list of 40 *EEA TERM indicators* is accordingly marked depending on the existence of their matching quantitative data (Table 3). As it can be observed from Table 4, not all the years have the complete list of quantitative data matching the 40 indicators. As in our case, we will be using the quantitative data for the year 2005. According to the Table 4 out of 40 indicators 22 TERM indicators are indicated as

<sup>18</sup> European Tire Recycling Association

<sup>19</sup> European Conference of Ministers of Transport

<sup>20</sup> Energy efficiency indicators of Europe

<sup>21</sup> Directorate-General Energy & Transport (of the European Commission)

<sup>22</sup> Regional Environmental Centre for Central and Eastern Europe

having the available quantitative data for this specific year. However, out of the 22 TERM indicators we have used only 16 as these had the most complete quantitative data for the EU27 Member States. The quantitative data sources which we have utilized for collecting the *EEA TERM* data have not necessarily matched those data sources mentioned in Table 3. The major source of data to quantify the *EEA TERM* indicators was Eurostat database. The following section focuses on the analysis of this data, visualised with the Dashboard software, to benchmark and assess transport sustainability performance in the EU27 Member States.

**Table 4.** Overview of the *EEA TERM* indicator fact sheets (EEA, 2007).

Indicator		2001	2002	2003	2004	2005	2006	2007
TERM 01	Transport final energy consumption by mode	+	+	+	+	+	+	+
TERM 02	Transport emissions of greenhouse gases	+	+	+	+	+	+	+
TERM 03	Transport emissions of air pollutants	+	+	+	+	+	+	+
TERM 04	Exceedances of air quality objectives due to traffic	+	+	+	+	+	+	+
TERM 05	Exposure to and annoyance by traffic noise	+	+					
TERM 06	Fragmentation of ecosystems and habitats by transport infrastructure	+	+					
TERM 07	Proximity of transport infrastructure to designated areas	+	+					
TERM 08	Land take by transport infrastructure	+	+					
TERM 09	Transport accident fatalities	+	+	+	+	+	+	+
TERM 10	Accidental and illegal discharges of oil at sea	+	+					
TERM 11	Waste oil and tires from vehicles		+					
TERM 11a	Waste from road vehicles (ELV)	+	+					
TERM 12a	Passenger transport			+	+	+	+	
TERM 12b	Passenger transport modal split by group of goods	+	+	+	+	+	+	+
TERM 13a	Freight transport			+	+	+	+	
TERM 13b	Freight transport modal split by group of goods	+	+	+	+	+	+	+
TERM 14	Access to basic services	+	+	+				
TERM 15	Regional accessibility of markets and cohesion	+		+				
TERM 16	Access to transport services	+	+					
TERM 18	Capacity of infrastructure networks	+	+	+	+	+		
TERM 19	Infrastructure investments	+	+					+
TERM 20	Real change in	+	+		+	+		+

	transport prices by mode								
TERM 21	Fuel prices and taxes	+	+	+	+	+	+	+	+
TERM 22	Transport taxes and charges				+	+	+	+	
TERM 23	Subsidies							+	
TERM 24	Expenditure of personal mobility by income group				+	+			+
TERM 25	External costs of transport		+	+	+	+	+		+
TERM 26	Internalisation of external costs	+	+	+	+	+	+	+	
TERM 27	Energy efficiency and specific CO <sub>2</sub> emissions	+	+	+	+		+		+
TERM 28	Specific emissions	+	+		+		+		+
TERM 29	Occupancy rates of passenger vehicles		+	+		+	+		
TERM 30	Load factors for freight transport	+	+	+		+	+		
TERM 31	Uptake of cleaner and alternative fuels	+	+	+	+	+	+	+	+
TERM 32	Size of vehicle fleet		+	+	+	+		+	
TERM 33	Average age of vehicle fleet	+	+	+	+		+		+
TERM 34	Proportion of vehicle fleet meeting certain emission standards	+	+	+	+	+		+	
TERM 35	Implementation of integrated strategies	+	+	+		+			
TERM 36	Institutional cooperation		+	+		+			
TERM 37	National monitoring systems	+	+	+		+			
TERM 38	Implementation of SEA	+	+	+		+			
TERM 39	Uptake of environmental management systems by transport companies	+							
TERM 40	Public awareness	+	+			+			

## 5.2 Analysis of the EEA TERM Indicators

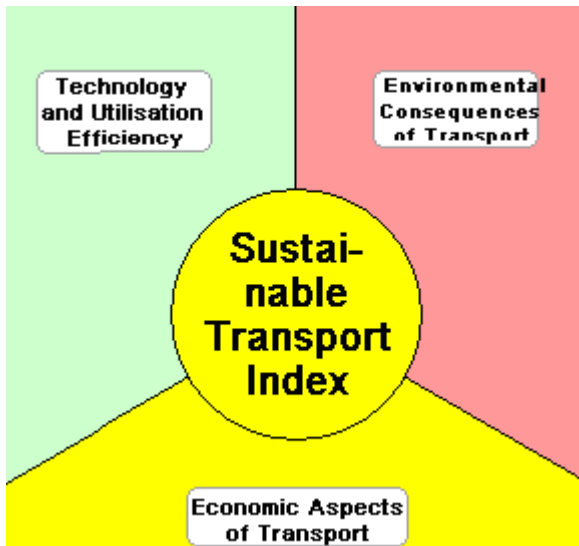
In this section, we present an aggregate sustainable transport index based on the *TERM* indicators, to which we refer to as the *TERM Sustainability Index*. Initially all *EEA TERM* indicators have been grouped into the three predominant dimensions, namely economic, environmental and technological. These three major groups, namely *Environmental Consequences of Transport*, *Economic Aspects of Transport* and *Technology & Utilisation Efficiency* have been formed following the original framework of the EEA TERM indicators (Table 5). Such grouping was necessary in order to facilitate the comparison of the two indices, the *JRC SusTrans* and the *EEA TERM*.



**Table 5.** Grouping of the *EEA TERM* Indicators into Three Sustainability Components

<b>Sustainability Dimension</b>	<b>Indicator</b>
<b>Economic Aspects of Transport</b>	Passenger transport (by mode and purpose)
	Freight transport (by mode and group of goods)
	Capacity of transport infrastructure networks (by mode and by type of infrastructure (motorway, national road, municipal road, etc.))
	Real change in passenger transport price by mode
	Fuel prices
	Fuel taxes
	Expenditure on personal mobility per person by income group
	Implementation of internalization instruments i.e. economic policy tools with a direct link with the marginal external costs of the use of different transport modes
<b>Environmental Consequences of Transport</b>	Transport final energy consumption by mode
	Transport emissions of greenhouse gasses (CO <sub>2</sub> and N <sub>2</sub> O) by mode
	Transport emissions for air pollutants (NO <sub>x</sub> , MNVOC <sub>s</sub> , PM <sub>10</sub> , SO <sub>x</sub> , total ozone precursors) by mode
	Exceedances of EU air quality objectives due to traffic (standards for PM <sub>10</sub> , NO <sub>2</sub> , benzene, ozone, lead and CO)
	Number of transport accidents, fatalities, injured, and polluting accidents (land, air and maritime)
<b>Technology and utilization efficiency</b>	Overall energy efficiency for passenger and freight transport (per passenger-km and per tonne-km and by mode)
	Load factors for freight transport (LDV, HDV)
	Uptake of cleaner fuels (unleaded petrol, electric, alternative fuels) and numbers of alternative-fuelled vehicles
	Average age of the vehicle fleet

In the Figure 43 the three composite parts of the *TERM Index* are displayed, namely, Environmental Consequences of Transport, Economic Aspects of Transport, and Technology and Utilisation Efficiency. The *EEA TERM Index* in comparison with the *SusTrans Index*, places high emphasis on the environmental dimension of sustainability, while such dimensions as social and institutional are not as strongly addressed. However, certain social and institutional aspects are dispersed and integrated within the presented three dimensions of the *EEA TERM Index*. Figure 43 shows the equal weight distribution in the aggregation of the *EEA TERM* Sustainability indicators.



Composition (weights in %):

*Sustainable Transport Index contains 3 indicators*

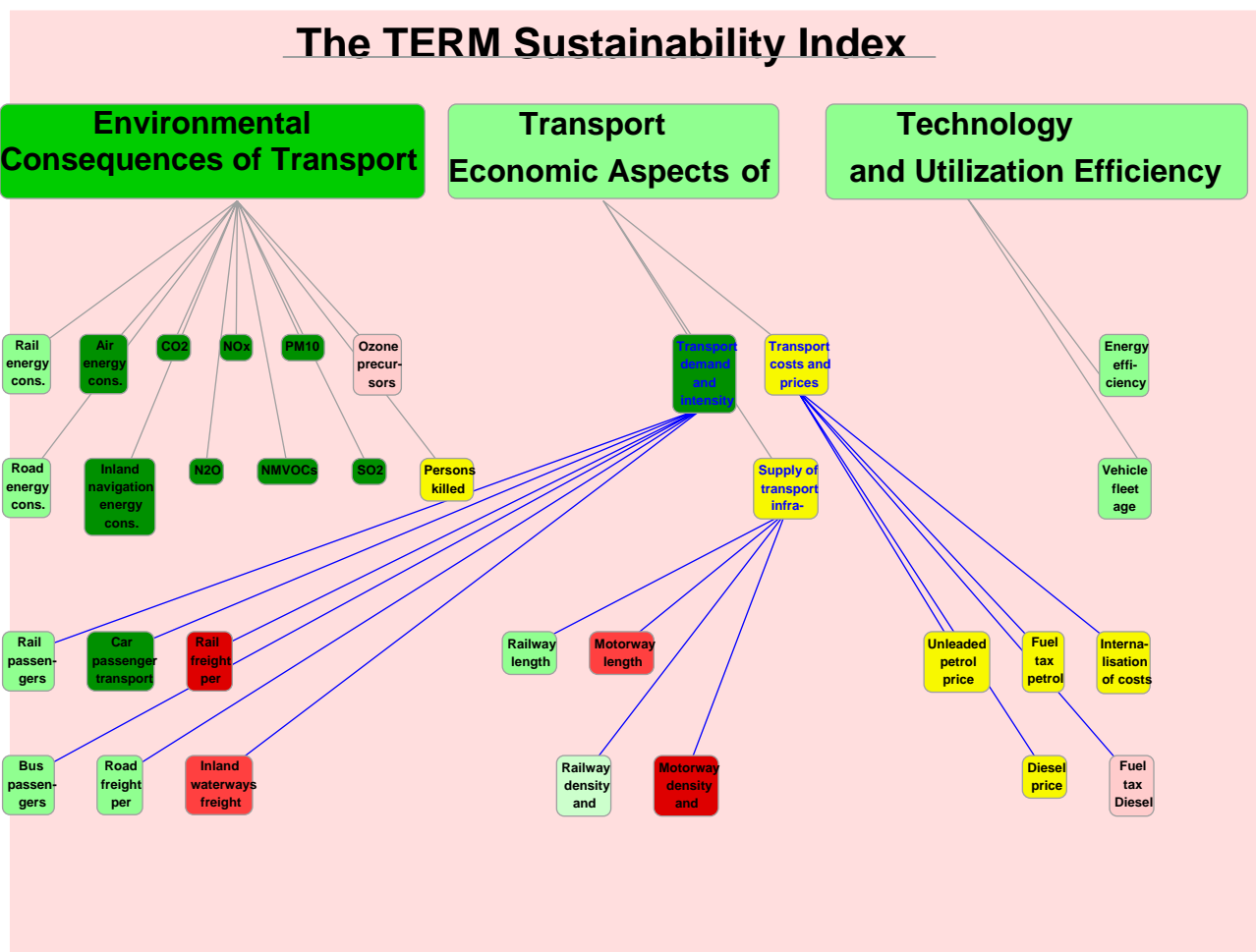
33.3 Environmental Consequences of Transport

33.3 Economic Aspects of Transport

33.3 Technology and Utilisation Efficiency

**Figure 43 Composition of the EEA TERM Index.**

Figure 44 presented below displays the structure of the *EEA TERM Sustainability Index* which was formed from the composite indicators of the *EEA TERM* indicator set.

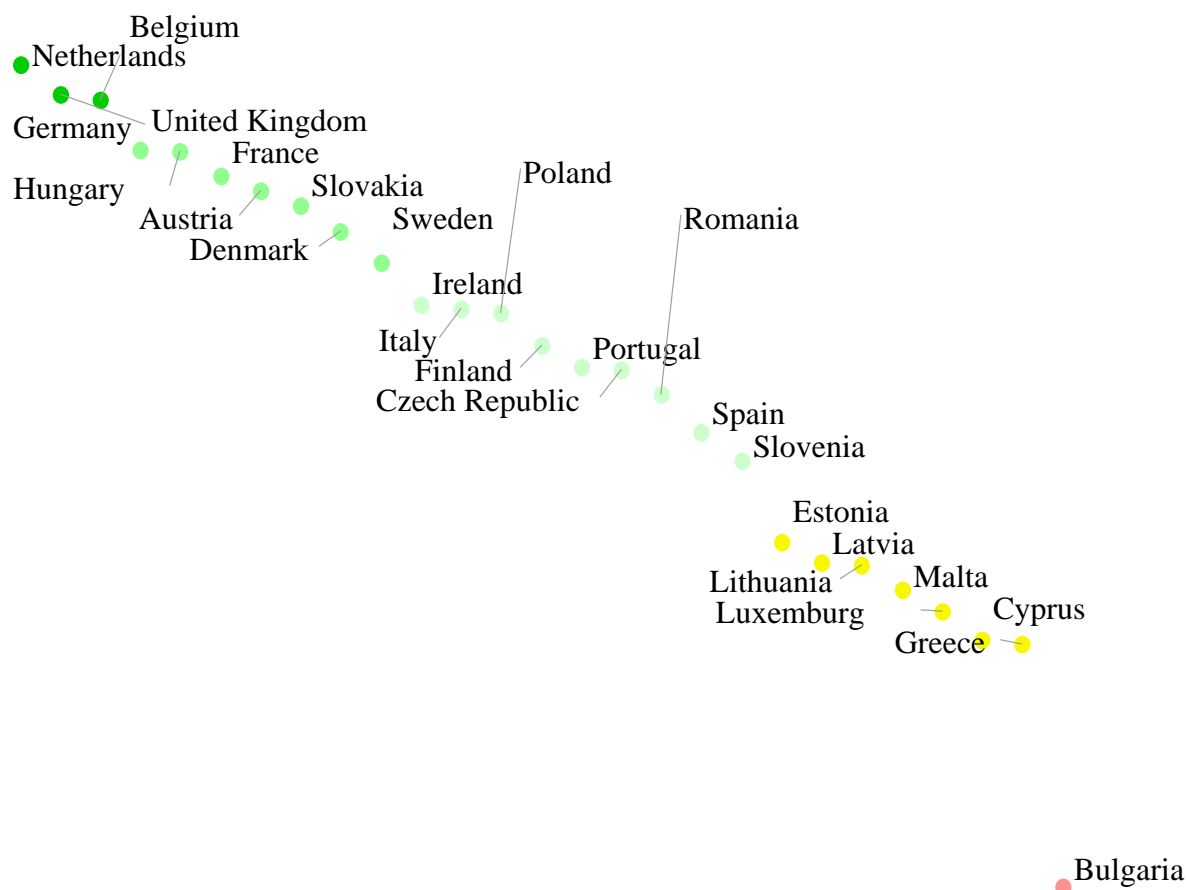


**Figure 44 Structure of the EEA TERM Index.**

Comparison of the *SusTrans* and the *TERM* indices reveal several similarities of their sustainability components. In principle, the major sustainability dimensions, which are economic, environmental and

social, are reflected in both transport related indices. This renders the two transport sustainability indices comparable. In our study we use the *EEA TERM Index* to benchmark the results of the *JRC SusTrans Index* and in this way to assess sustainability performance of transport activities. The evaluation of these indices allows to compare and to assess transport activities in the individual EU Member States using the two different approaches. Eventual aim of this comparison is to propose means to address the major weaknesses and strengths of transport systems and to suggest adequate sustainability policies to improve performance of transport activities. The two indices are comparable also because they are constructed using the same indicator aggregation approach based on equal weight distribution. The calculations of quantitative performance in both indices are made using the same tool, the Dashboard of Sustainability.

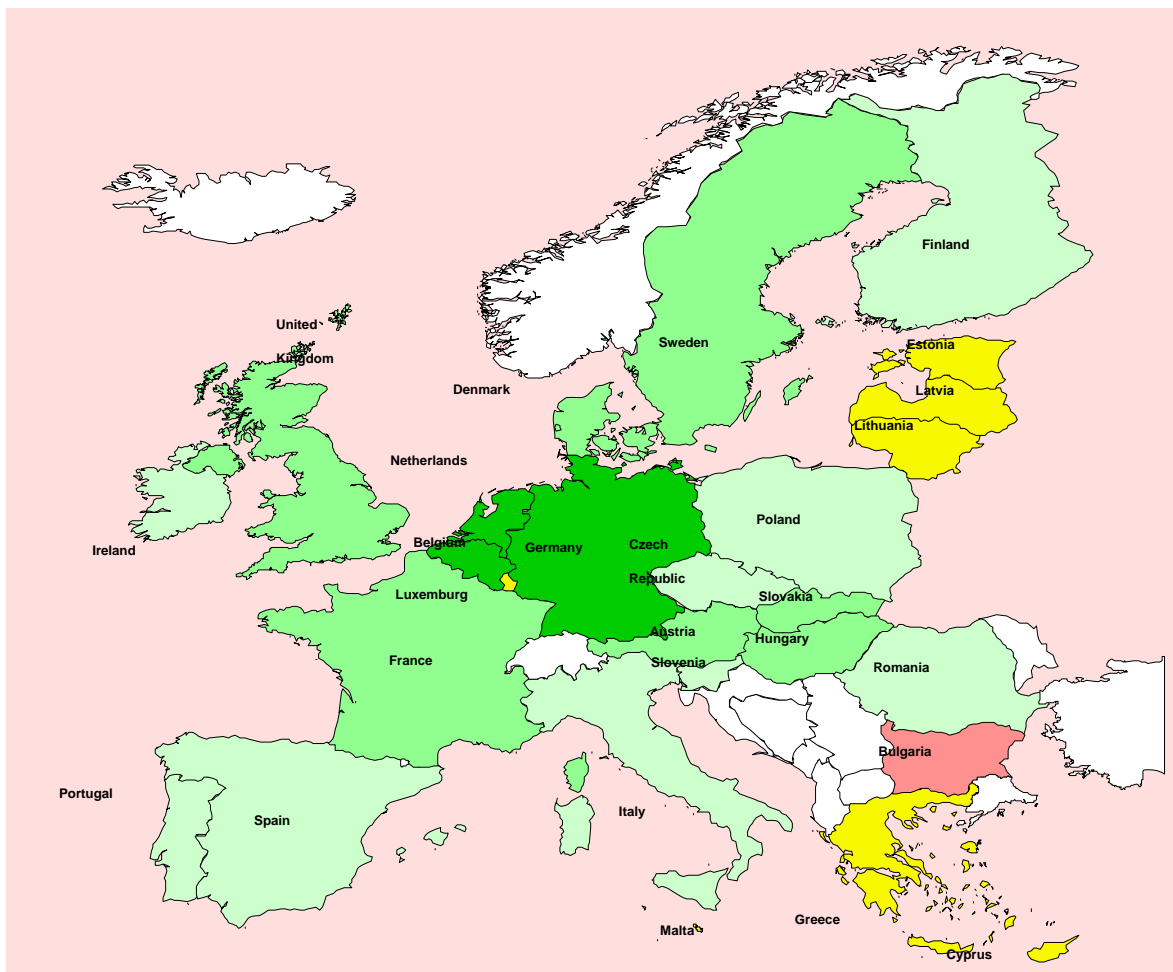
As it can be observed from the results obtained from the *EEA TERM Index*, the Netherlands have the best overall performance in transport sustainability, while Bulgaria scores lowest (Figure 45). According to the *JRC SusTrans Index* Germany has obtained the highest ranking place, while the lowest one was given to Greece. Similarities between these results of the two indices are that the countries with highest and lowest sustainability performances are neighboring countries (e.g. Germany and Netherlands) or belong to the same geographic region (Bulgaria and Greece are comprising parts of Balkan Peninsula).



**Figure 45 Ranking Performance of the EU Member States according to the EEA TERM Sustainability Index.**

Figure 46 presents transport sustainability performance based on the *EEA TERM Index* reflected in the EU map. Positive transport sustainability performance is observed in the Central and Northern EU Member States. According to the both transport sustainability indices, the New EU Member States, namely the Baltic States, have had relatively low sustainability performance of transport activities. The specific reasons for these performance results may be understood by looking at the individual composite indicators of the *EEA TERM Index* and by comparing them to the *JRC SusTrans* indicators.

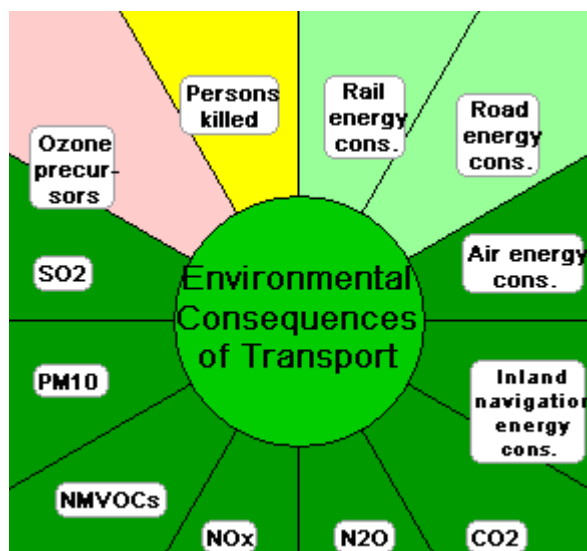
We have analyzed all the three major *EEA TERM Index* components as separate entities. As a starting point we have focused on the Index of Environmental Consequences.



**Figure 46 Sustainability Performance in the EU Member States according to the EEA TERM Index (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 5.3 Environmental Consequences of Transport

The *Index of Environmental Consequences* contains 12 indicators (Figure 47) of environmental dimension and these are individually addressed in this report. These indicators address *transport energy consumption*, *transport emissions* and *road accident* based information.



Composition (weights in %):

*Index Environmental Consequences of Transport*  
contains 12 indicators

- 8.3 Rail tr.energy consumption
- 8.3 Road tr.energy consumption
- 8.3 Air tr. energy consumption
- 8.3 Inland navigation energy consumption
- 8.3 CO2 emissions
- 8.3 N2O emissions
- 8.3 NOx emissions
- 8.3 Emissions of NMVOCs
- 8.3 PM10 emissions
- 8.3 SO2 emissions
- 8.3 Tropospheric ozone precursors
- 8.3 Persons killed in road accidents

**Figure 47 Composition of the Index of Environmental Transport Consequences**

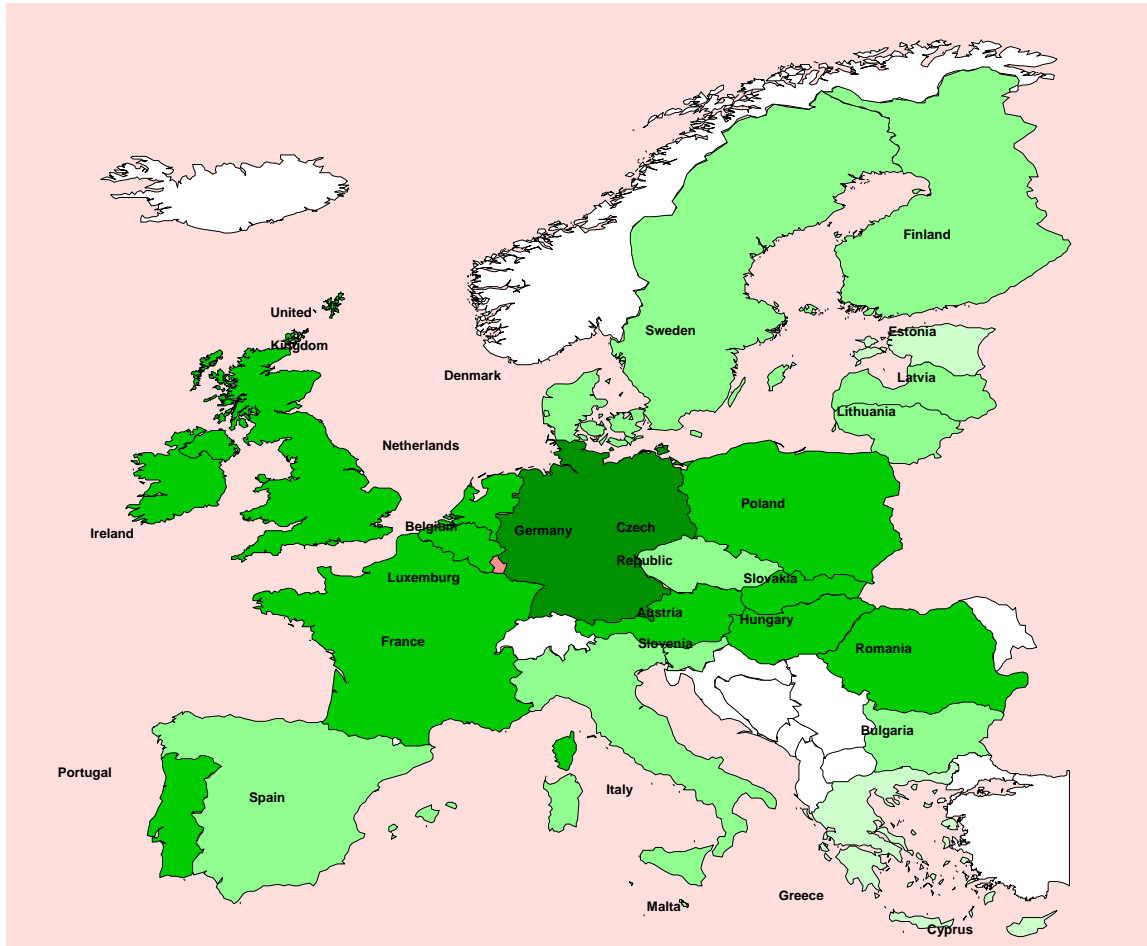
In terms of the environmental dimension of the *TERM Index* the best overall ranking score among the EU 27 Member States has been obtained by Germany and the lowest performance rank – by Luxemburg (Figure 48 and Figure 49). Similarly also according to the *SusTrans Index* Germany had also the highest environmental transport sustainability performance and Luxemburg has been given the lowest rank.



**Figure 48 Ranking of the EU Member States according to the Index of Environmental Consequences.**

In spite of similar outcomes obtained by the two indices, there are many similarities but also differences between the *JRC SusTrans* and the *EEA TERM* indices in terms of composition of

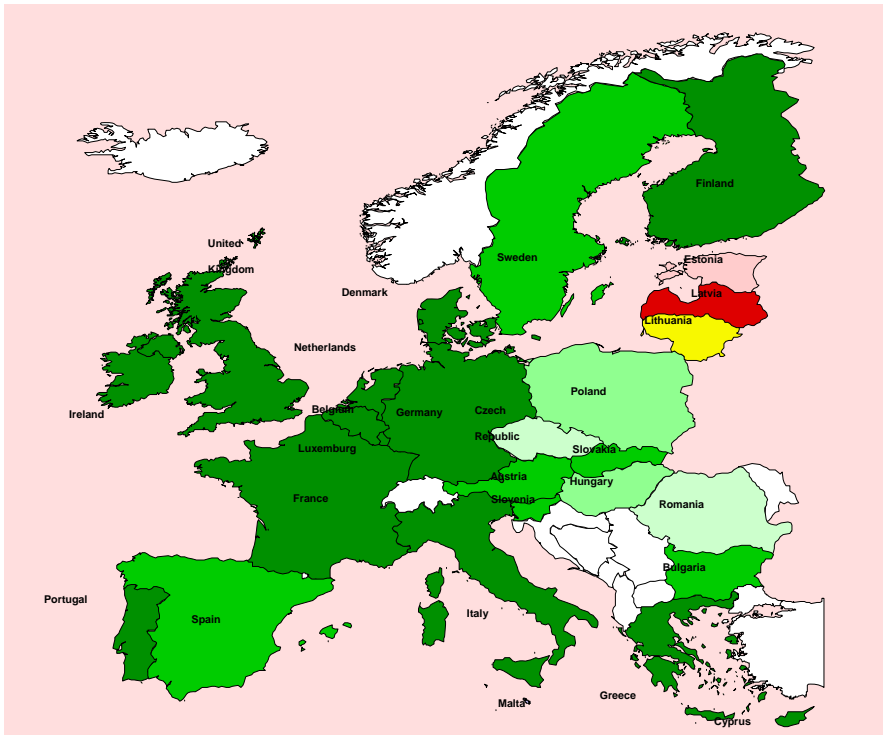
environmental sustainability dimension. The environmental dimension of the *JRC SusTrans Index* includes such various aspects as transport emissions, transport energy consumption, fuel consumption, the use of renewable resources in transport activities. The environmental dimension of the *EEA TERM Index* focuses mainly on the emissions, energy consumption in transport as well as on the road accident rates. Differently from the *EEA TERM Index*, the indicator of road accidents within the *JRC SusTrans Index* is incorporated under the social dimension of transport sustainability.



**Figure 49 Sustainability Performance in the EU 27 on the basis of the Index of Environmental Transport Consequences (green color denotes high sustainability performance, yellow- medium and red - low performance).**

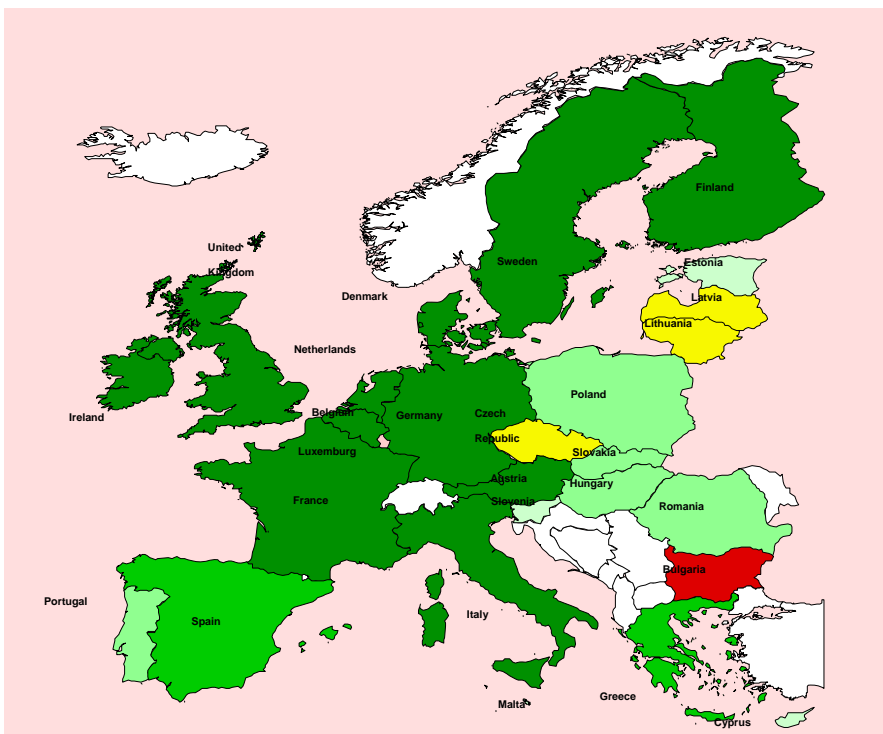
### 5.3.1 Transport Energy Consumption

The large part of indicators within the component of environmental consequences of transport of the *EEA TERM Index* deals with energy consumption in rail transport, road transport, air transport and inland navigation transport sectors. The indicator of rail transport energy consumption reveals that the highest sustainability performance value is in Cyprus and the lowest – in Latvia (Figure 50).



**Figure 50 Sustainability Performance in the EU27 in terms of Energy Consumption by Rail (green color denotes high sustainability performance, yellow- medium and red - low performance).**

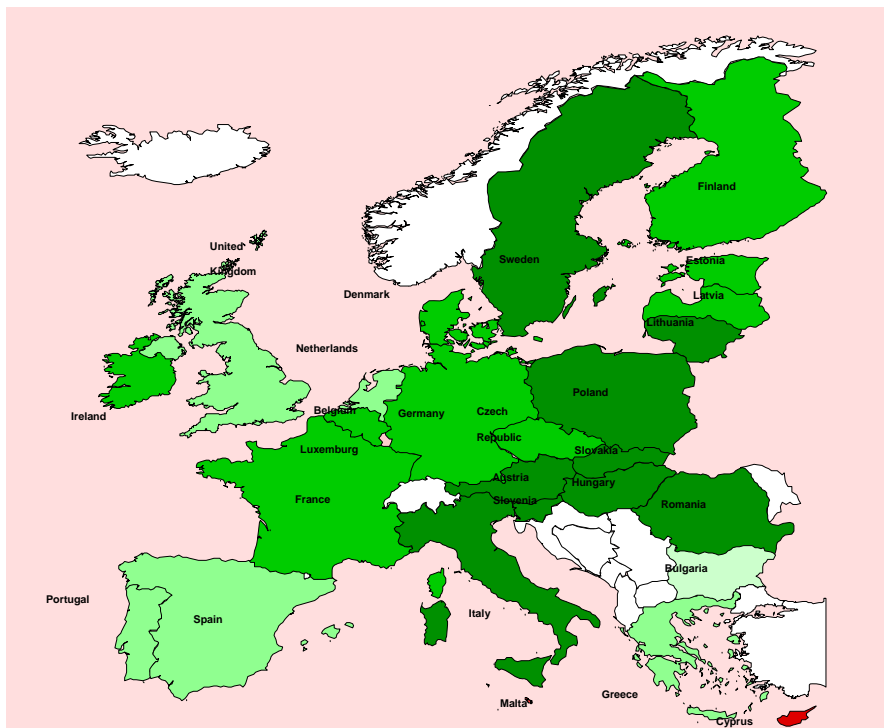
Energy consumption by all transport modes has been reported to increase in most of the EU Member States (EEA, 2004). From Figure 50 it can be observed that energy consumption by rail transport is the highest in the New EU Member States, more specifically the Baltic States. However, rail transport sector is known for high energy efficiency and this is due to the advantages presented by the railway system because of the predominance of electric traction (EC, 2009).



**Figure 51 Sustainability Performance in the EU27 in terms of Energy Consumption by Road Transport (green color denotes high sustainability performance, yellow- medium and red - low performance).**

Similar situation is found also in terms of road transport. Road transport energy consumption is the highest in the New EU12 and lower consumption is observed in the EU15. Energy consumption by road transport indicator has the best performance in Denmark and the lowest – in Bulgaria (Figure 51). According to the recent data (EC, 2009), road transport has improved its energy consumption by 20% mainly due to the technological developments in vehicles used in passenger transport.

We have also looked at the data related to the air transport energy consumption, which reveals that the best sustainability performance has Slovenia, while the lowest – Cyprus. However the data set related to energy consumption in air transport is not very complete and thus we do not discuss in more detail the map presented in Figure 52 (many values of the EU countries are based on the Dashboard estimates). It has been reported that energy consumption in aviation sector has made some progress due to the fleet renewal and higher occupancy factors (EC, 2009).

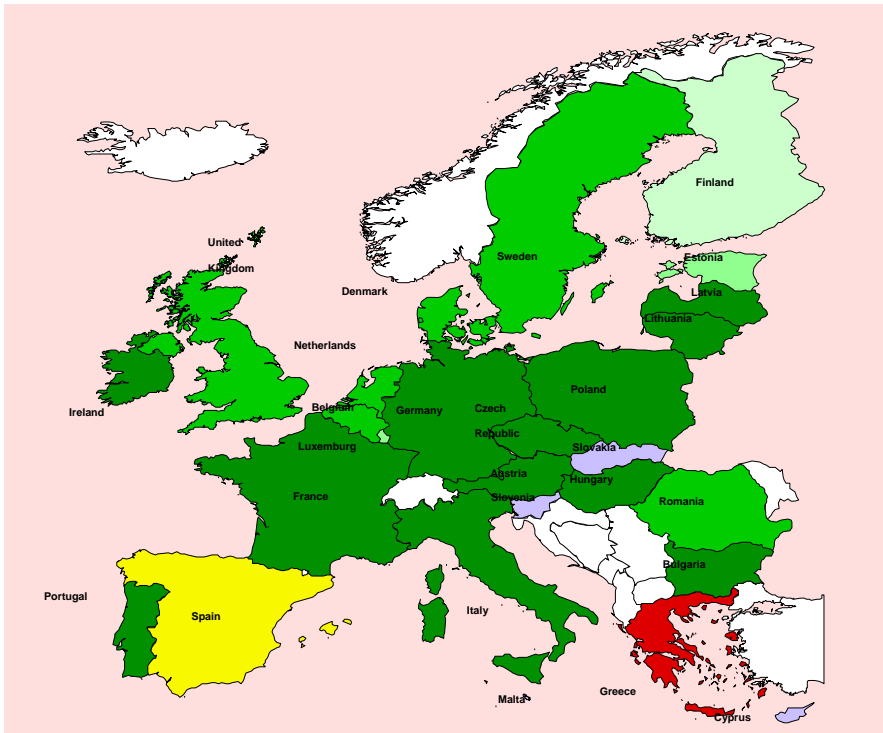


**Figure 52 Sustainability Performance in the EU27 in terms of Energy Consumption by Air Transport (green color denotes high sustainability performance, yellow- medium and red - low performance).**

In terms of energy consumption, which is closely linked to emissions of greenhouse gases and climate change, aviation is an important and growing sector. Aircrafts contribute to climate change by direct climate forcing from emitted CO<sub>2</sub> and also indirectly through the formation of condensation trails and increased formation of cirrus clouds (IPCC, 1999). As mentioned in the EEA (2004) publication on “Key transport and environmental issues” air transport is growing so rapidly that its climate impacts will soon exceed those of passenger vehicles and by 2030, the impact is predicted to be twice as large.

Finally, in terms of energy consumption we have inland waterways indicator, which reveals the highest energy consumption value for Lithuania and the lowest – for Greece (Figure 53). However, the maritime transport remains the most energy- efficient transport mode per single traffic unit performed (EC, 2009).





**Figure 53 Sustainability Performance in the EU27 in terms of Energy Consumption by Inland Navigation Transport (green color denotes high sustainability performance, yellow- medium and red - low performance).**

After discussing the energy consumption indicators of the *EEA TERM Index*, we analyze how this compares to the *JRC SusTrans Index* outcomes. According to the *SusTrans Index* the lowest energy efficiency performance of transport activities is in general observed in the Northern part of the EU and Central Eastern EU Member States. The results of the two indices are similar: the largest transport energy consumption has been identified mostly in the EU15. Currently various transport sustainability policies of the EU are focused on the improvement of energy efficiency performance by implementing various economic instruments, by improving the technological state of vehicles which allows saving energy and by applying various environmental standards to reduce energy consumption in transport sector.

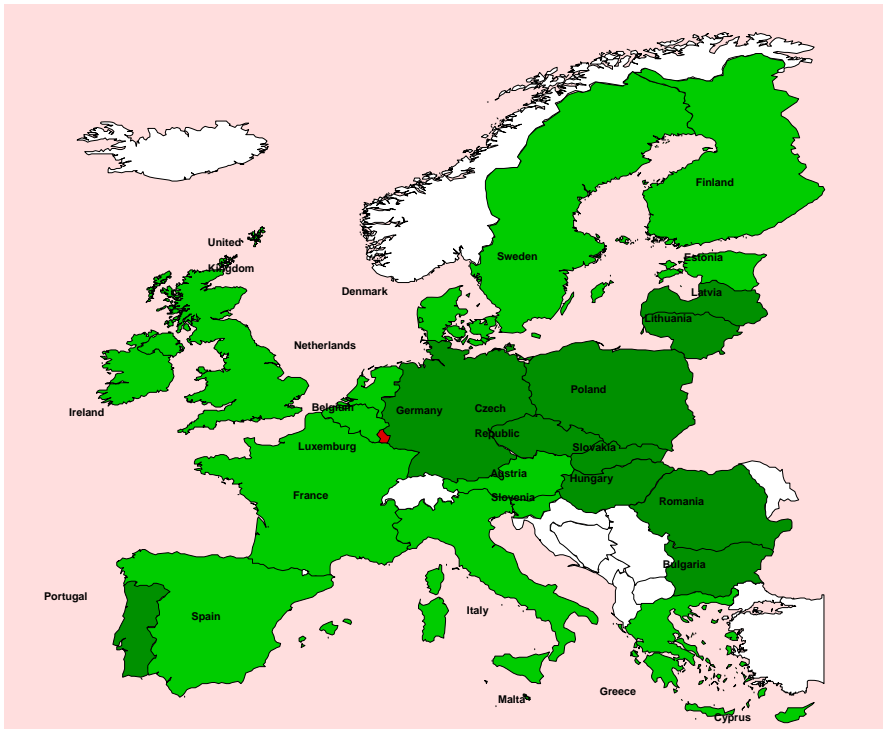
### 5.3.2 Transport Emissions

Emission indicators of the *TERM Index* focus on the following transport emissions: CO<sub>2</sub>, N<sub>2</sub>O, NO<sub>x</sub>, NMVOCs, SO<sub>2</sub>, PM<sub>10</sub> and Troposphere ozone precursors. Similarly, the *SusTrans Index* takes into account such specific emissions as NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO<sub>2</sub>, VOCs, emissions of O<sub>3</sub> precursors, N<sub>2</sub>O, CH<sub>4</sub> and SO. Road transport has been identified to be the single main source of nitrogen oxides, carbon monoxide and non-methane volatile organic compounds and the second-most significant source of fine particulates in the EU27 (EEA, 2006).

Population living in urban environments and in large agglomerations suffers the most from the exposure to transport emissions. Exposure to these pollutants may damage health in the short and long term, may affect natural ecosystems as well as attack buildings and materials. Moreover, air pollutants affect acidification of forests and water ecosystems, cause eutrophication of soils and waters leading to the lack of oxygen in freshwater bodies (EEA, 2009).

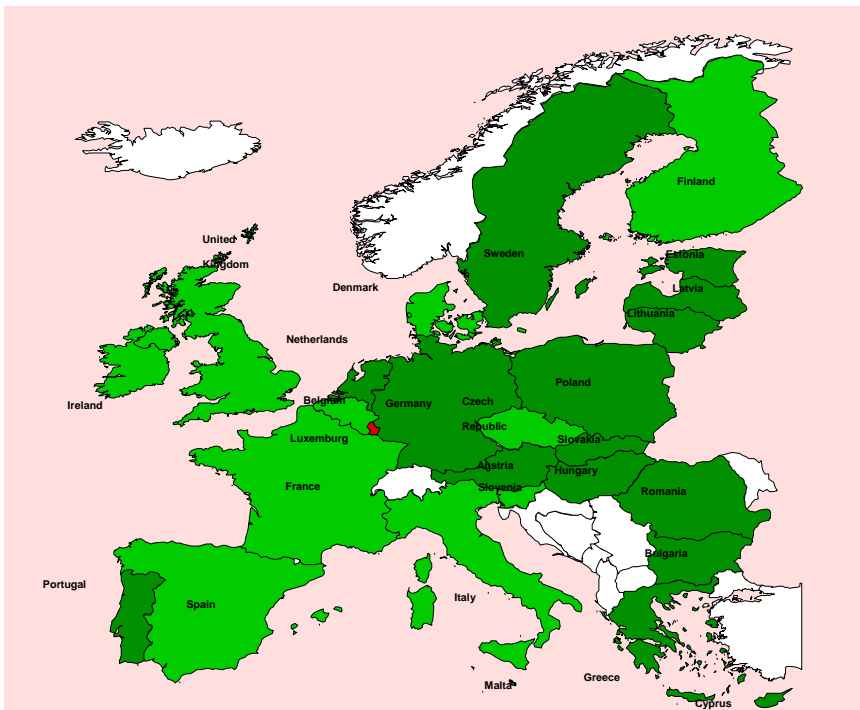
The transport sector is responsible for the significant amount of the CO<sub>2</sub> emissions. Total transport CO<sub>2</sub> emissions are rising, making it more difficult to meet the Kyoto targets. While passenger cars have become more efficient, the growth in transport demand has been greater, resulting in a net increase of about 20 % in greenhouse gas emissions from transport over the past decade. This nevertheless the voluntary commitment by European automakers (ACEA) in limiting the average CO<sub>2</sub>

emissions of new passenger cars from 186 g/km in 1995 to 140 g/km by 2008 (EEA, 2004). Especially, significant concern is created by the raising GHG emissions from the aviation sector. Recently the EU has put in place measures to include aviation in the EU ETS (Emission Trading Scheme), to reduce new car CO<sub>2</sub> emissions and to lower the GHG intensity in road fuel (EC, 2009). As shown in Figure 54, in terms of CO<sub>2</sub> emissions from transport sector the best performance rank has Romania and the worst – Luxembourg.



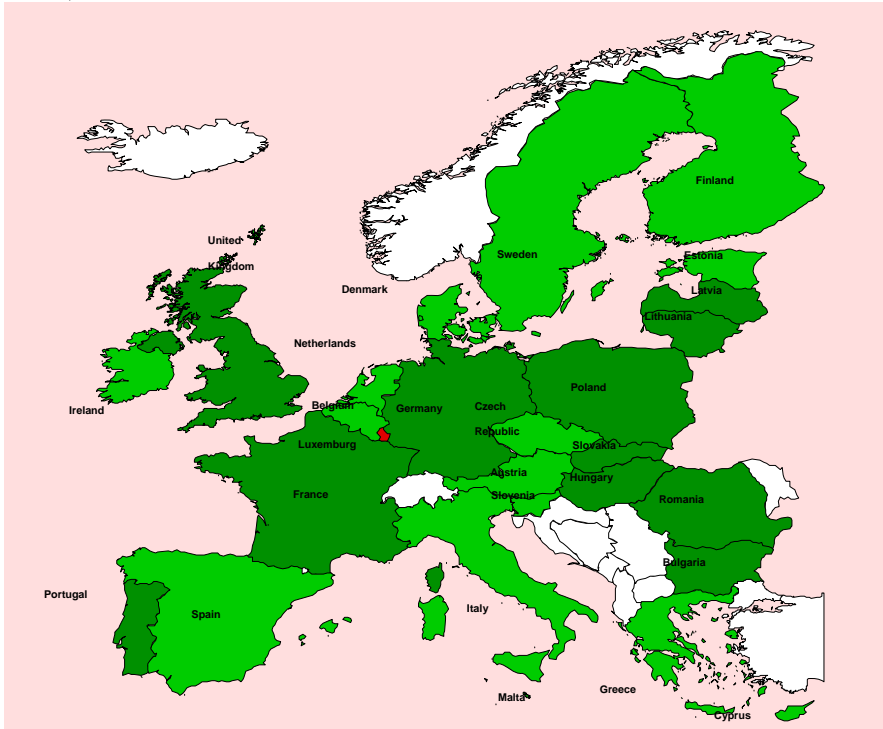
**Figure 54 Sustainability performance in the EU Member States in terms of the CO<sub>2</sub> Emissions (green color denotes high sustainability performance, yellow- medium and red - low performance).**

Similarly to CO<sub>2</sub> emissions, in terms of N<sub>2</sub>O emissions, the best value has Romania and the worst – Ireland (Figure 55).

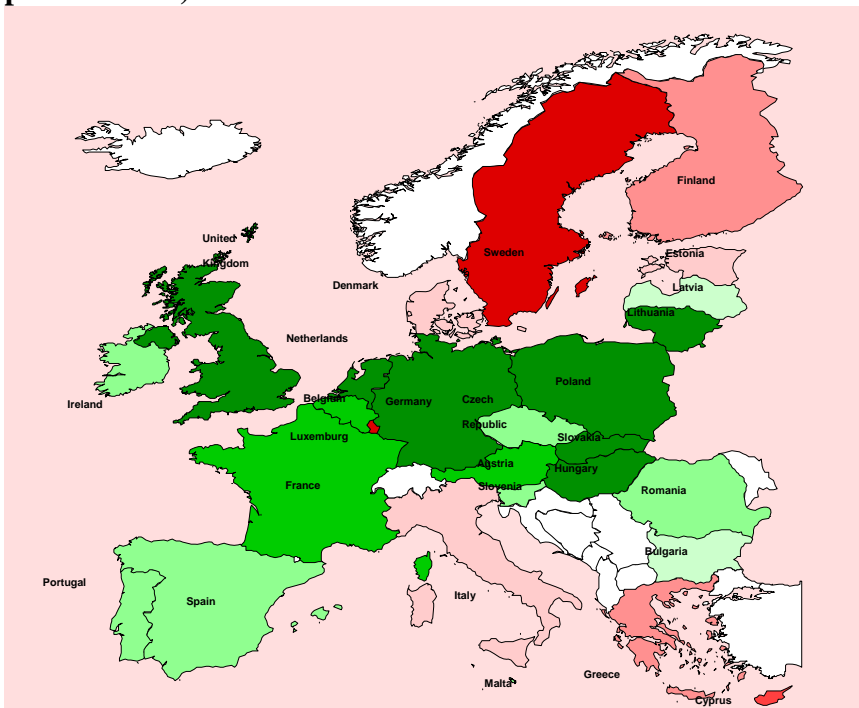


**Figure 55 Sustainability performance in the EU Member States in terms of N<sub>2</sub>O Emissions (green color denotes high sustainability performance, yellow- medium and red - low performance).**

NOx emissions are also very significant in terms of transport activities. The nitrogen oxides ceiling remains the most difficult to comply with in terms of EU National Emission Ceilings Directive (NEC, 2001). This is mainly due to faster than expected growth of road transport. Moreover, NOx emissions from aviation are also considered threatening and are planned to be addressed by the EU in 2009 (EC, 2009).



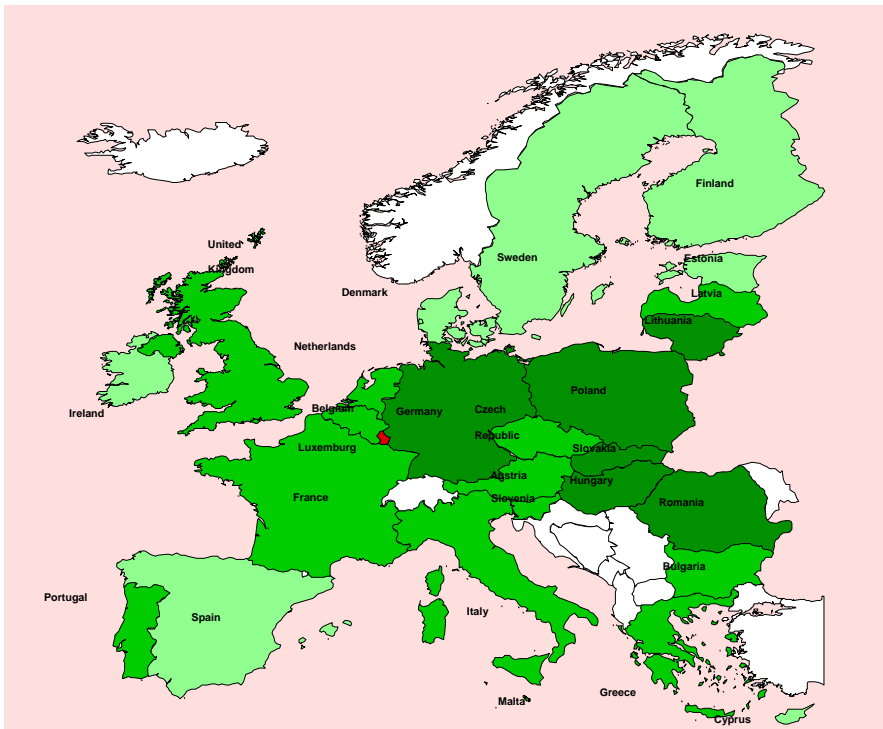
**Figure 56 Sustainability performance in the EU Member States in terms of NOx Emissions (green color denotes high sustainability performance, yellow- medium and red - low performance).**



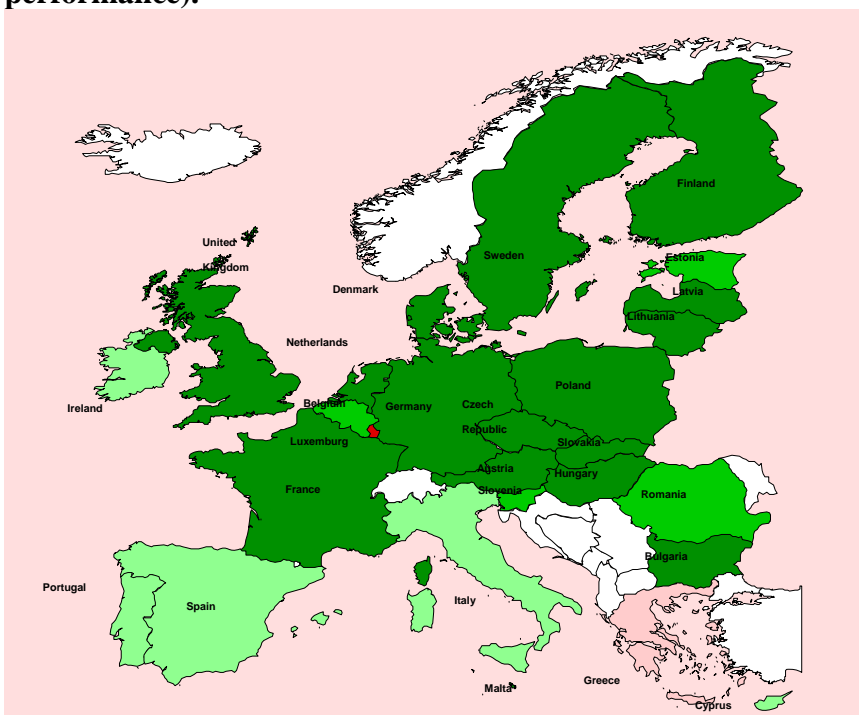
**Figure 57 Sustainability performance in the EU Member States in terms of MNVOCs Emissions (green color denotes high sustainability performance, yellow- medium and red - low performance).**

Regarding the NO<sub>x</sub> emissions, the best performance situation is in Slovakia and the worst – in Luxembourg (Figure 56). In terms of MNVOCs emissions the best ranking place among the EU States takes Germany, the lowest one – again Luxembourg (Figure 57).

Transport sector significantly contributes also to particulate matter emissions. Particulate matter from vehicle exhausts is damaging for peoples' lungs as well as posing a risk to the weakest population groups (people suffering of heart and respiratory problems) (EEA, 2009). In terms of PM<sub>10</sub> emissions the best performance value is – in Slovakia, the lowest ranking value - in Luxembourg (Figure 58).

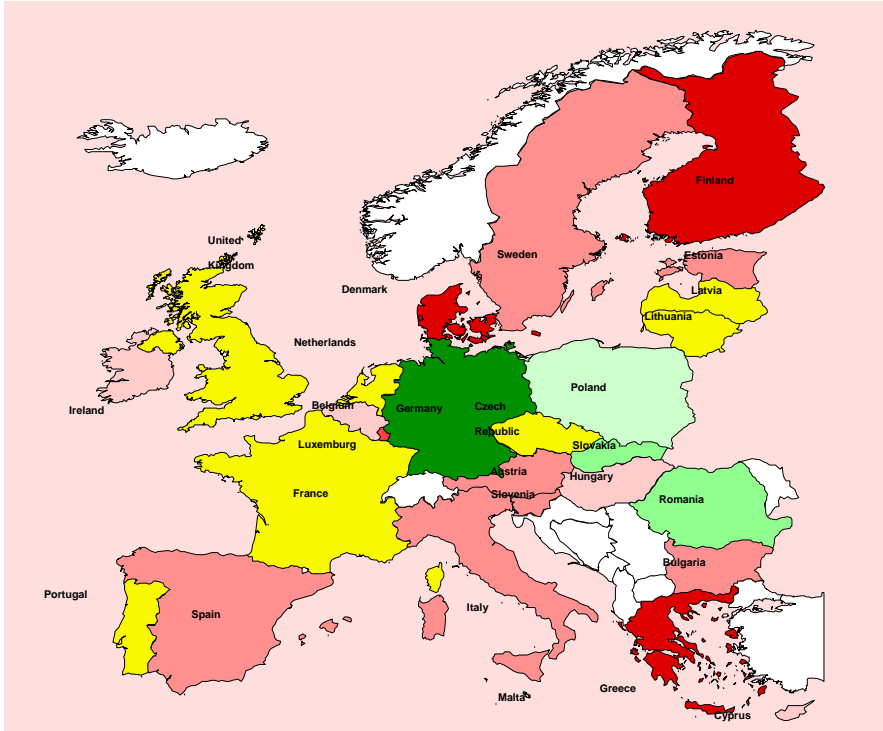


**Figure 58 Sustainability performance in the EU Member States in terms of PM<sub>10</sub> Emissions (green color denotes high sustainability performance, yellow- medium and red - low performance).**



**Figure 59 Sustainability performance in the EU Member States in terms of PM10 Emissions (green color denotes high sustainability performance, yellow- medium and red - low performance).**

In terms of SO<sub>2</sub> the best value is for Slovakia and the worst – for Luxembourg (Figure 59) and regarding trophospheric ozone precursors, the best sustainability performance has Germany and the worst performance – Greece (Figure 60).

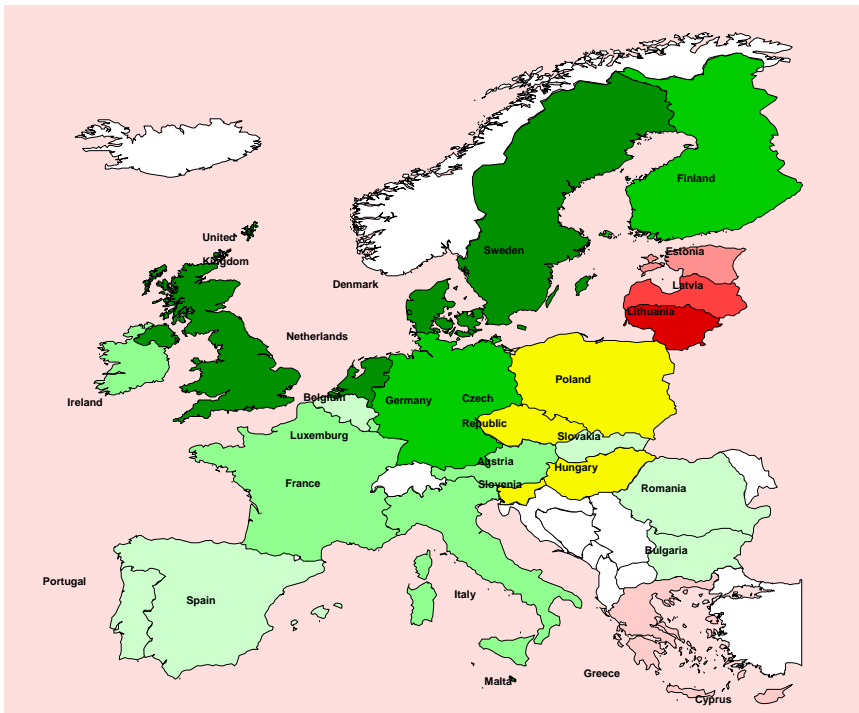


**Figure 60 Sustainability performance in the EU Member States in terms of Trospoheric Ozone Precursors (green color denotes high sustainability performance, yellow- medium and red - low performance).**

In general, the *EEA TERM Index* emissions as well as in the *JRC SusTrans Index* emission data indicates that EU12 have higher emissions compared to the EU15. This tendency is constant for all the emissions as shown in the emission maps of the *EEA TERM* emission indicators. In general, due to the tightening of air emissions from road vehicles through the application of EURO standards, road transport emissions have been reduced (EEA, 2008).

### 5.3.3 Road Accidents

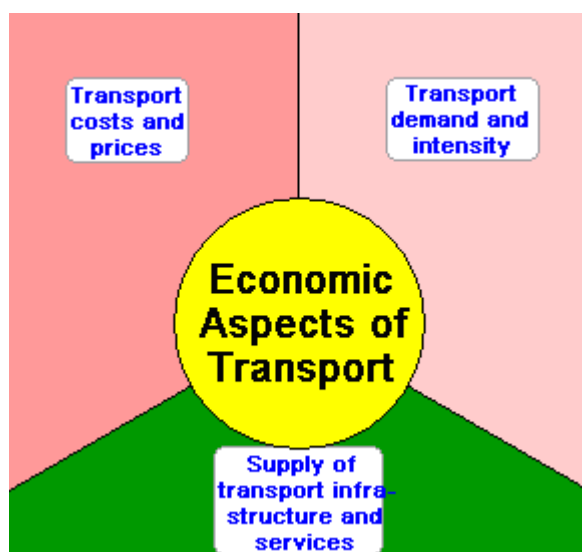
The indicator if the road accident rates within the *EEA TERM Index* belongs to the group of environmental consequences indicators, while in the *JRC SusTrans Index* this specific indicator is assigned to the social dimension of transport sustainability. As far as it is concerned the road accidents – the Malta has the lowest rates of people killed in road accidents and the worst performance indicating the largest road accident rates is observed in Lithuania and, in general, in the Baltic States (Figure 61).



**Figure 61 Sustainability performance in the EU Member States in terms of Persons killed in road accidents (green color denotes high sustainability performance, yellow- medium and red - low performance).**

## 5.4 Economic Aspects of Transport

Economic dimension of transport sustainability within the *EEA TERM Index* focuses on three major aspects, which include the indicator of *transport demand and intensity*, *supply of transport infrastructure* and *transport costs and prices* (Figure 62). Similarly to the *EEA TERM Index*, the *JRC SusTrans Index* also focuses on the same three major issues which are transport demand, transport costs and infrastructure. The differences in the economic dimension between the *JRC SusTrans Index* and the *EEA TERM Index* lie in the composition of sub-indicators within this economic dimension. The *SusTrans Index* takes into account slightly higher number of issues (sub-indicators) corresponding to these three major indicators.

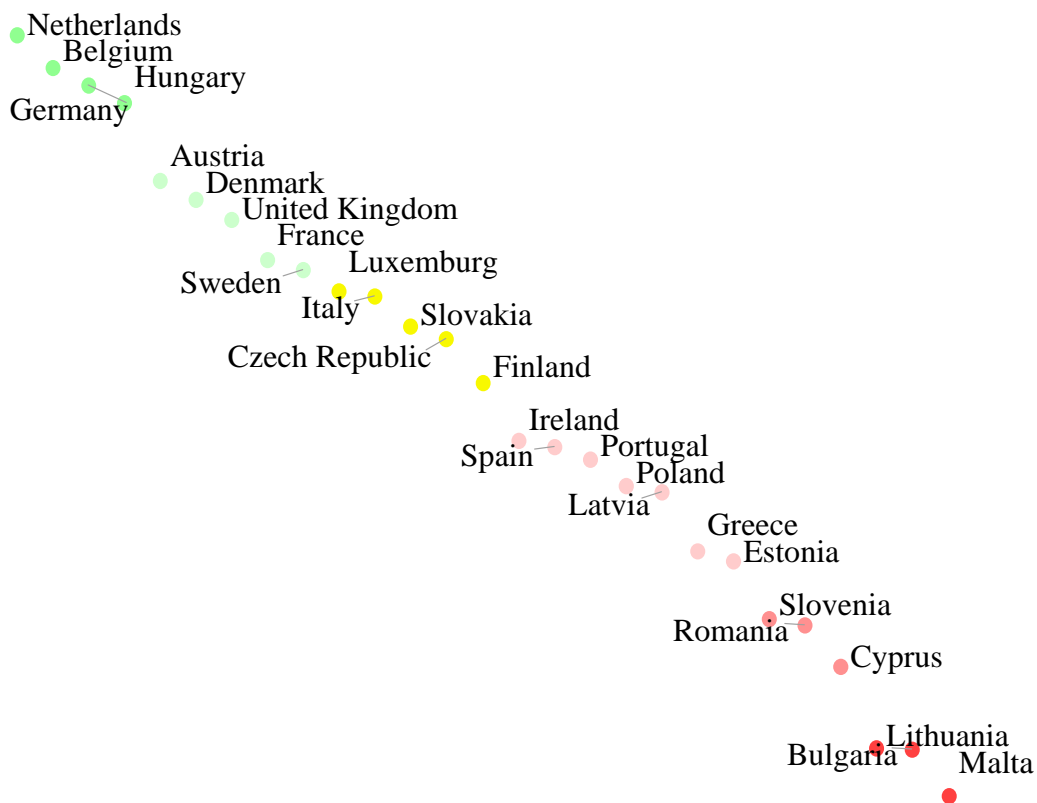


Composition (weights in %):

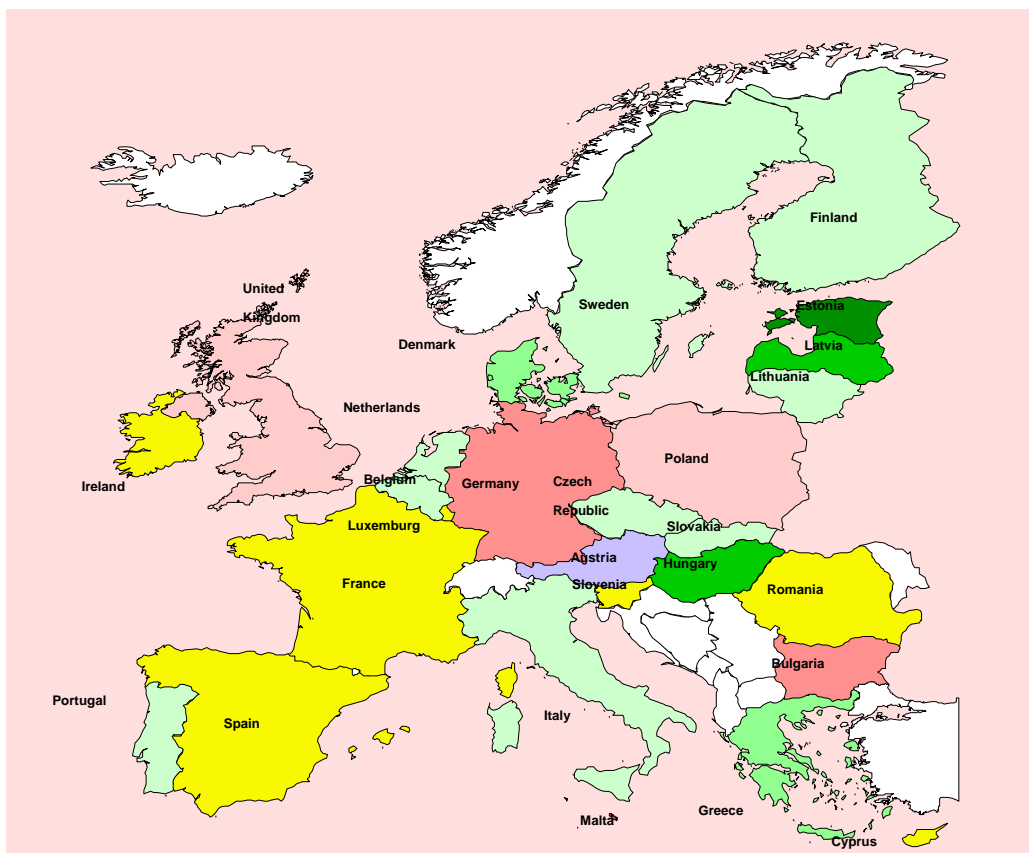
*Index Economic Aspects of Transport contains 3 indicators*

- 33.3 Transport demand and intensity
- 33.3 Supply of transport infrastructure and services
- 33.3 Transport costs and prices

**Figure 62 Composition of the Economic Aspects of the EEA TERM Index.**



**Figure 63 Ranking of the EU27 based on the Index of Economic Aspects of Transport.**



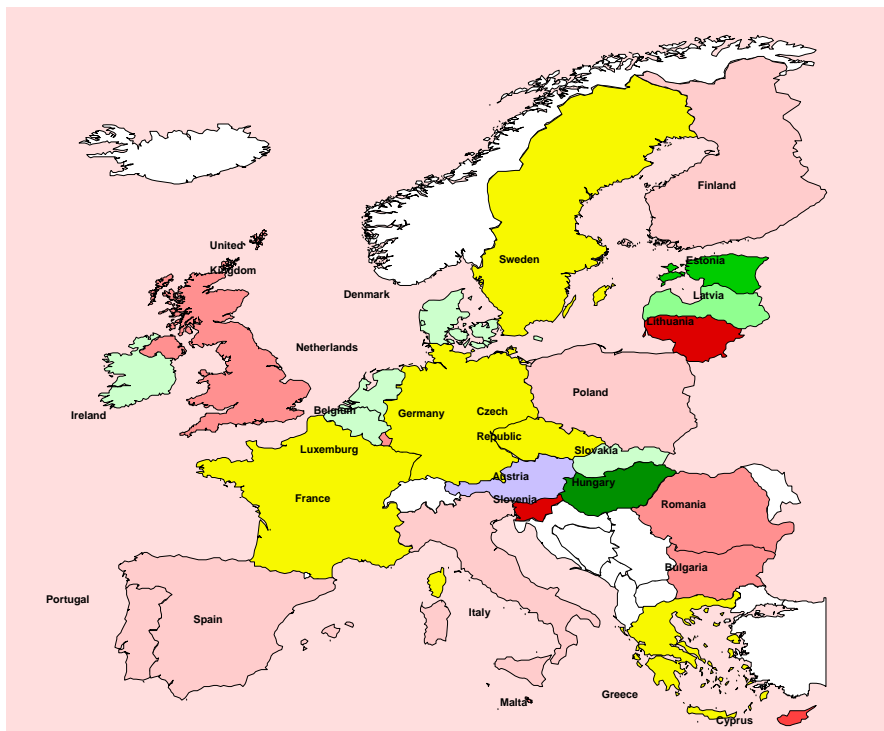
**Figure 64 Map based on the Index of Economic Aspects of Transport (green color denotes high sustainability performance, yellow- medium and red - low performance).**



From the Figure 63 and Figure 64 it can be observed that the best value in terms of economic transport sustainability performance according to the *EEA TERM Index* is obtained by Netherlands, while the lowest one – by Malta. Similarly to the *JRC SusTrans Index*, this index shows the economic transport sustainability performance in general is higher in the older EU Member States compared to the New EU Member Countries. However specific differences and similarities between the two transport sustainability indices in country ranking we will analyze by looking at each composite sub-index individually in the sub-sections below.

#### 5.4.1 Transport Demand and Intensity

As the Figure 65 shows the best performance value in terms of transport demand and intensity according to the *TERM Index* is obtained by Hungary and the lowest one – by Slovenia. According to the *SusTrans Index*, transport intensity is the highest in Netherlands and the lowest transport intensity is recorded in Bulgaria. In general, both indices, the *SusTrans Index* and the *TERM Index*, agree that intensity of transport activities is quite high in the majority of the Eastern EU Member Countries, suggesting high loads of transport passing through this area and, thus, taking all the burden of negative transport impacts on sustainability.

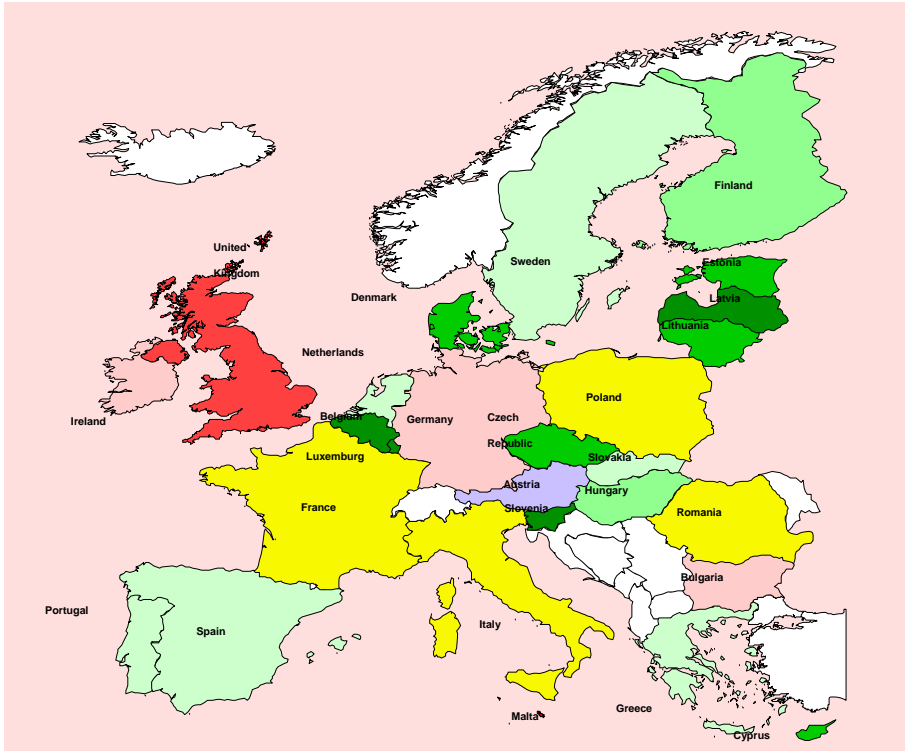


**Figure 65 The EU Map reflecting Transport Demand and Intensity (green color denotes high sustainability performance, yellow- medium and red - low performance).**

#### 5.4.2 Supply of Transport Infrastructure and Services

In the Figure 66, the indicator of supply of transport infrastructure and services of the *EEA TERM Index* is presented. The best performance value is obtained by Luxembourg, while the worst one – by Malta. The same ranking result for these two countries is obtained also by the indicator of infrastructure according to the *SusTrans Index*.

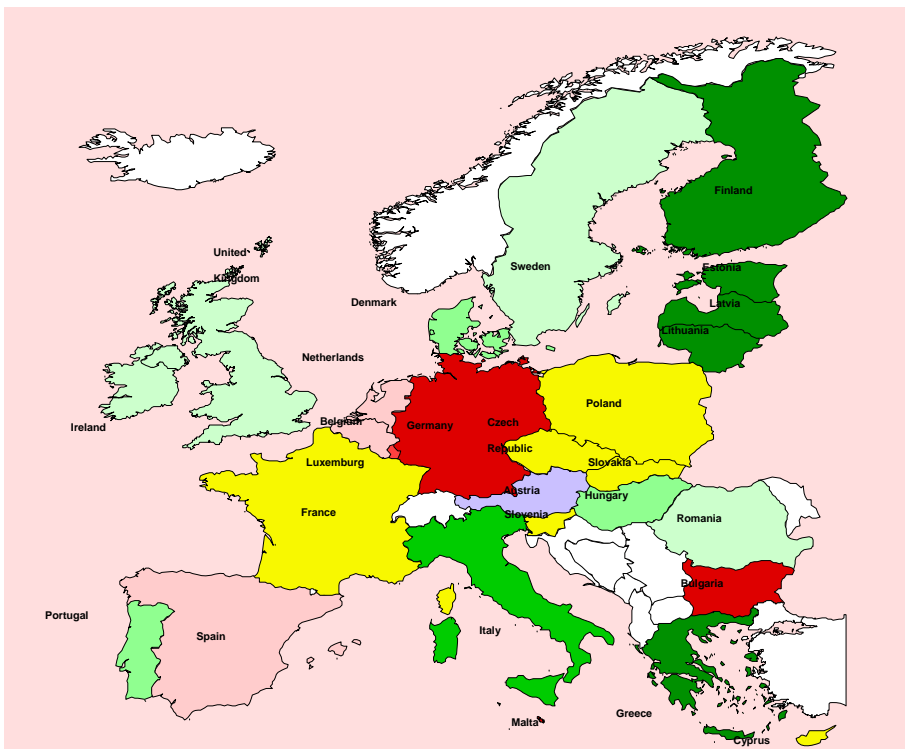




**Figure 66 Supply of Infrastructure and Services in the EU (green color denotes high sustainability performance, yellow- medium and red - low performance).**

#### 5.4.3 Transport Costs and Prices

In the Figure 67, the EU map shows that in terms of transport costs and prices according to the *EEA TERM Index* the best sustainability performance has the United Kingdom and the lowest – Bulgaria. Similarly, according to the indicator of transport costs of the *SusTrans Index* the highest performance is obtained by the UK, while the lowest – by Lithuania. The differences in performance results of the two indices are due to the composite structure of these indices (i.e. the *SusTrans Index* includes slightly higher number of diverse sub-indicators representing the overall indicator of transport costs).

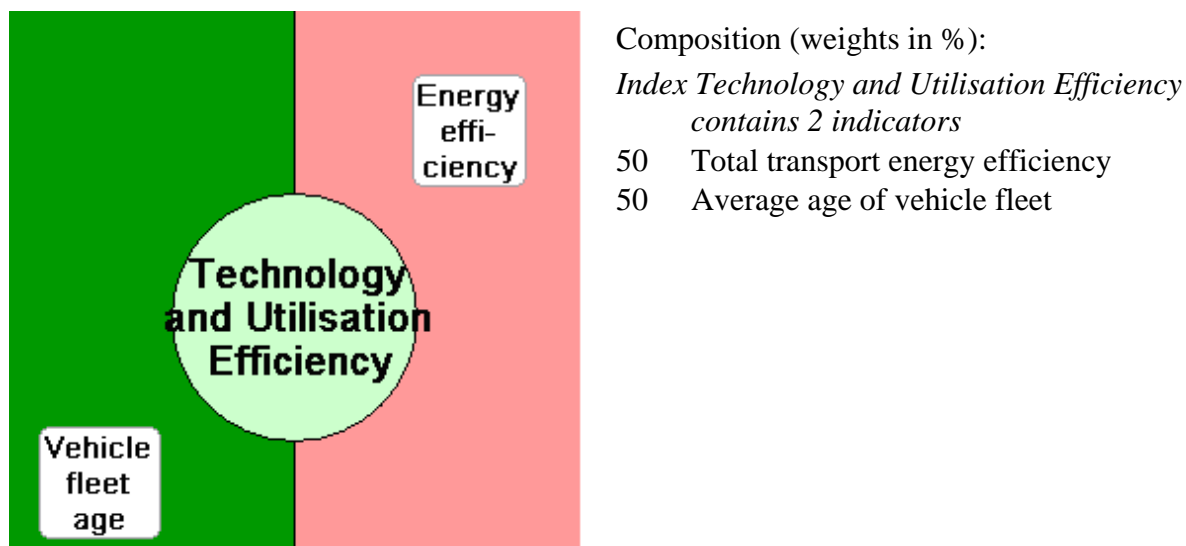


**Figure 67 Transport costs and prices in the EU (green color denotes high sustainability performance, yellow- medium and red - low performance).**

In summary, the results in terms of transport sustainability performance of economic dimension of the *TERM Index* are similar to the outcomes obtained by the *SusTrans Index*. The small differences observed between the two indices are due to the different number of sub-components in the composite indicators of this sustainability dimension.

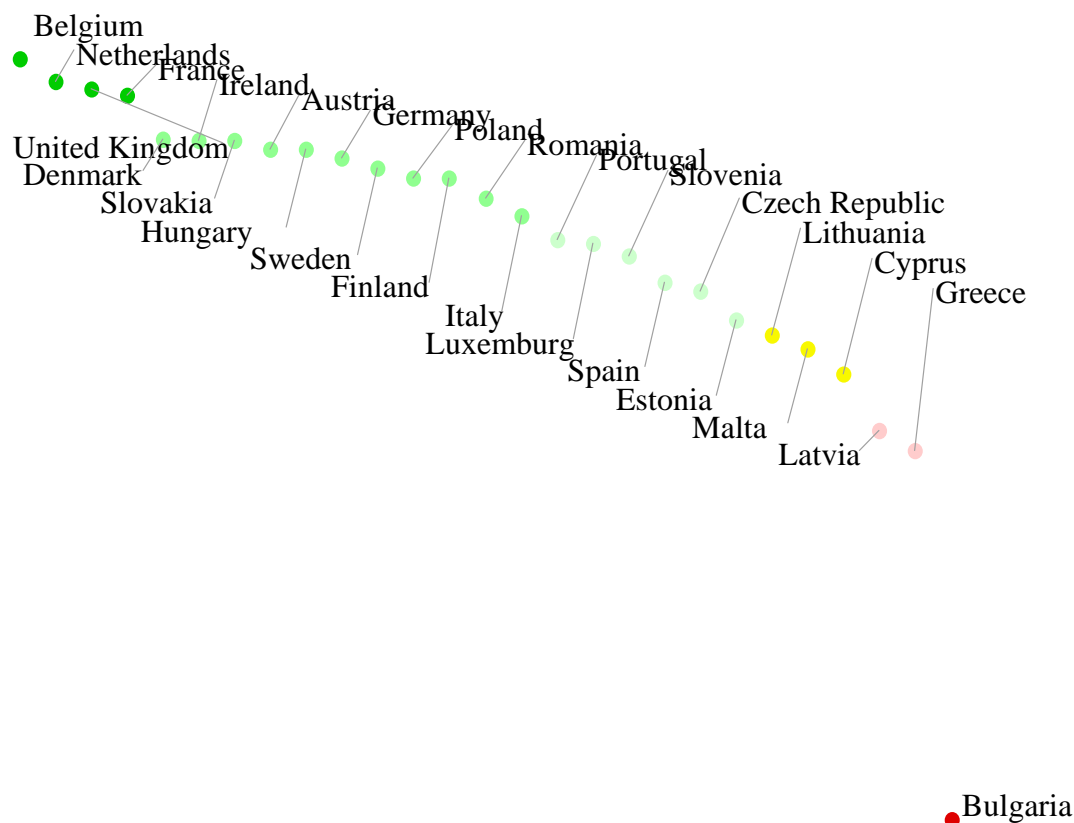
### 5.5 Technology and Utilization Efficiency

The Index of Technology and Utilization Efficiency within the *EEA TERM Index* is comparable to the technical-operational dimension of the *JRC SusTrans Index*. There are two major composite parts of the Index of Technology and Utilization Efficiency, namely *total transport energy efficiency* and *average age of vehicle fleet* (Figure 68). Both, technical dimensions of the *TERM Index* and the *SusTrans Index* include the indicator of average age of vehicle fleet. Differently from the *EEA TERM Index*, the indicator of energy efficiency is assigned to the environmental dimension within the *JRC SusTrans Index*. Additionally, technical-operational dimension of the *JRC SusTrans Index* includes such supplementary indicators as occupancy rate (load) of vehicles and vehicles meeting environmental-technical standards.

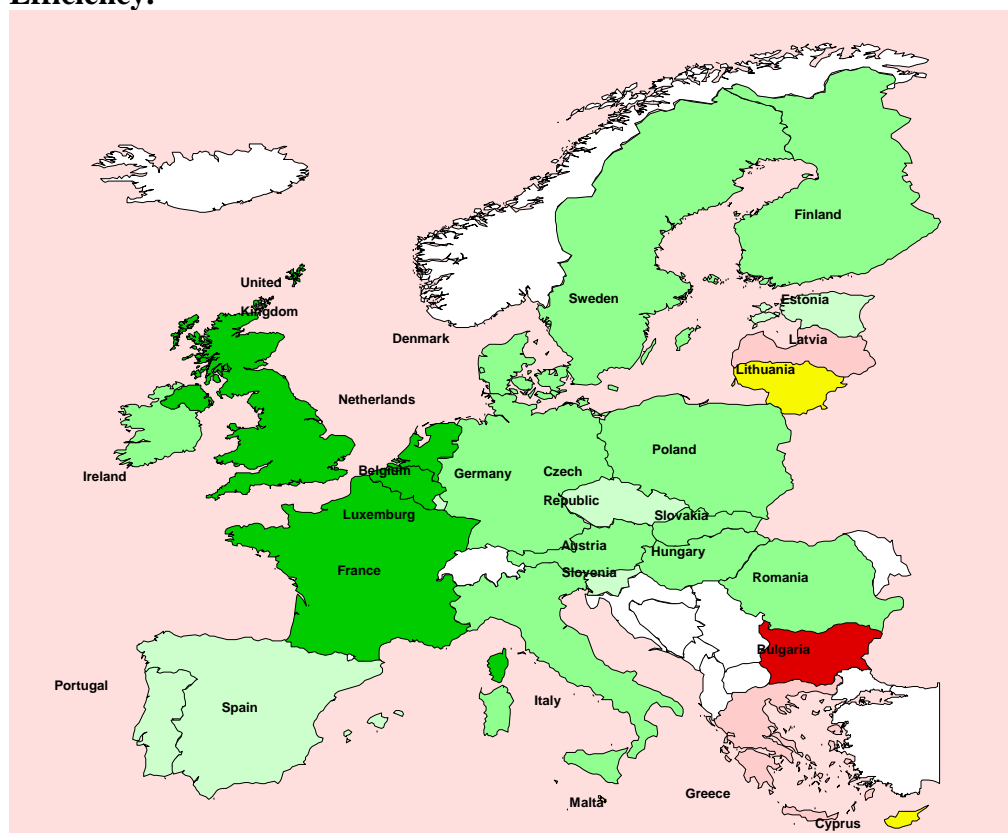


**Figure 68** Composition of the Index of Technology and Utilization Efficiency.

Figure 69 and 70 indicate that the best ranking value in terms of technology and utilization efficiency according to the *EEA TERM Index* is observed in Belgium and the lowest sustainability performance is in Bulgaria. The reasons for this ranking are analyzed on the basis of the ranking performance of the two composite indicators, which are 1) transport energy efficiency and 2) average age of vehicle fleet. Similar to the results of the *EEA TERM Index*, the highest ranking performance of technical-operational dimension of the *SusTrans Index* is also observed in Belgium and the lowest performance score is obtained by Greece (which is also part of Balkan Peninsula as their neighbor Bulgaria).



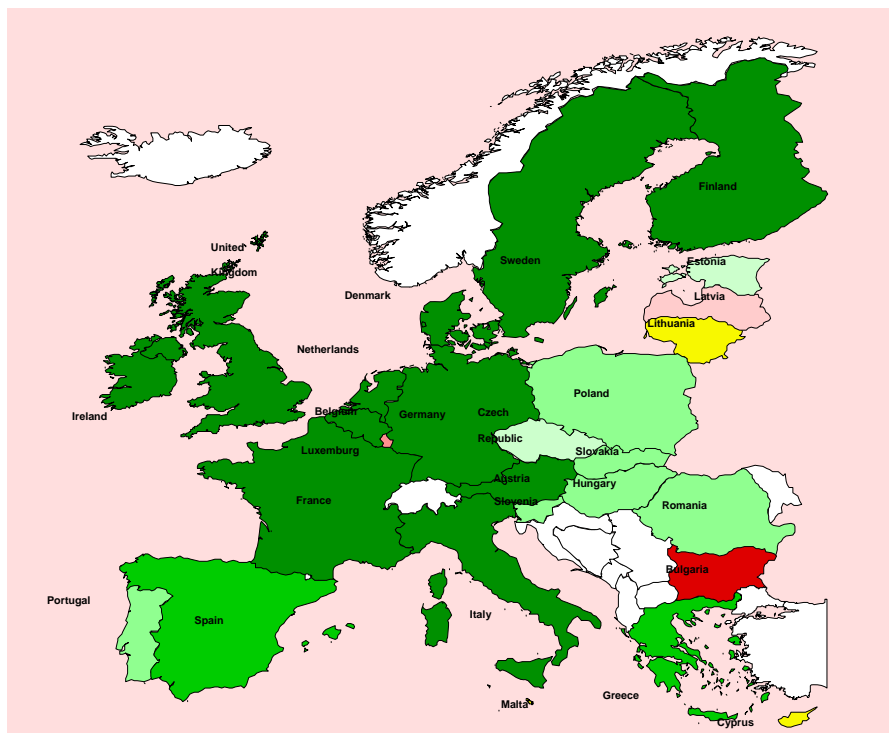
**Figure 69 Ranking of the EU Member States in terms of the Index of Technology and Utilization Efficiency.**



**Figure 70 Map of the EU Member States Performance Ranking in terms of Technology and Utilization Efficiency (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 5.5.1 Total Transport Energy Efficiency

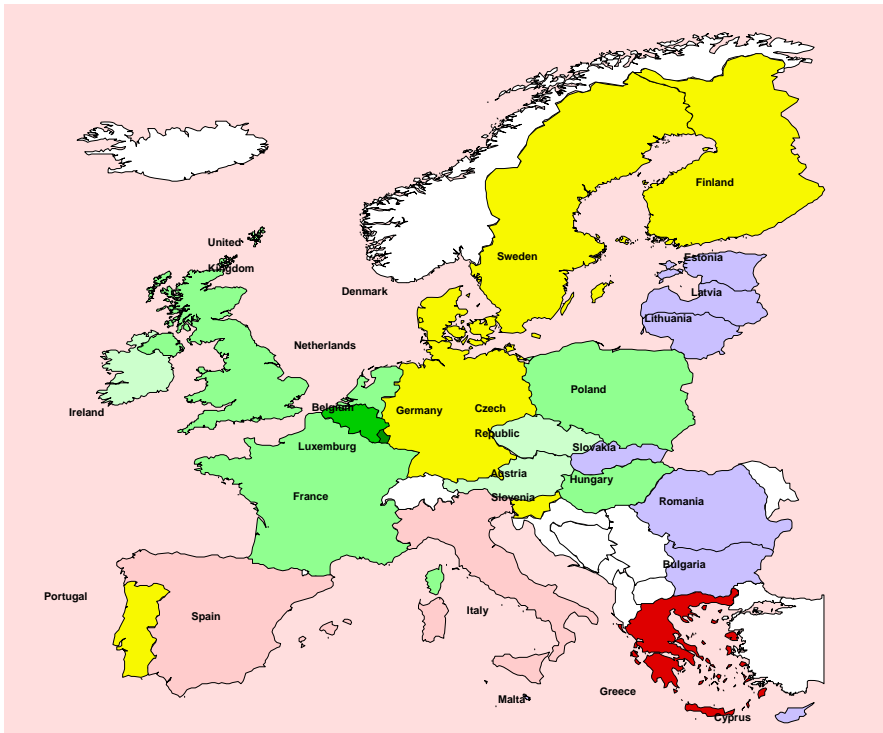
As shown in the Figure 71, the older EU Member States tend to have higher transport energy efficiency performance compared to the New EU Member States. The best sustainability performance value in terms of energy efficiency has been observed in Denmark and the lowest – in Bulgaria. In terms of transport energy efficiency performance the results of the *JRC SusTrans Index* are quite similar to the *EEA TERM Index* outcomes indicating the highest energy efficiency in the North of the EU and the Central EU Member States.



**Figure 71 Map of the EU Member Countries Performance on the basis of Total Transport Energy Efficiency (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 5.5.2 Average Age of Vehicle Fleet

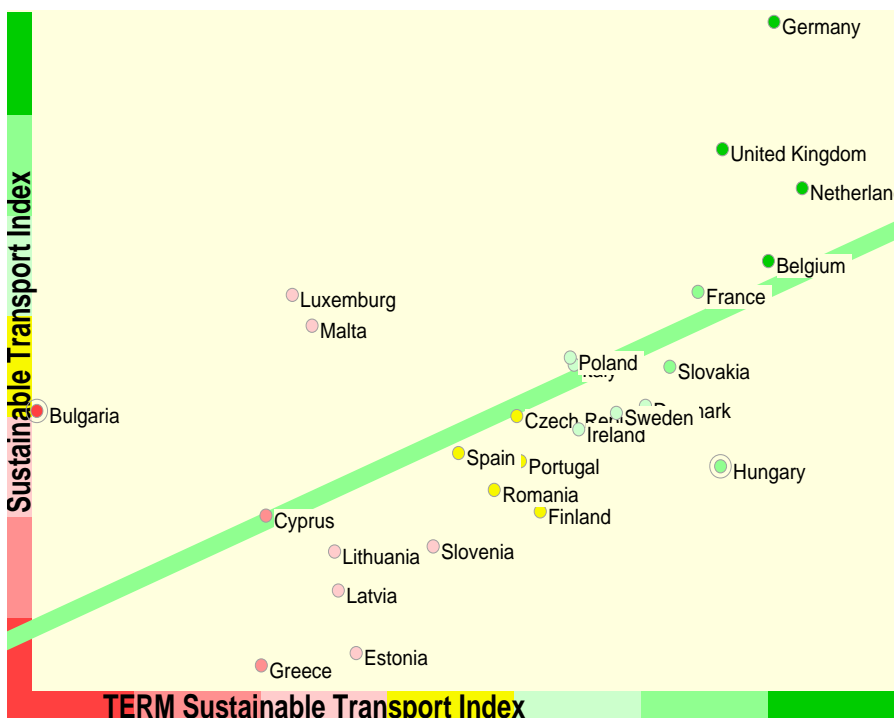
As shown in the Figure 72, according to the *EEA TERM Index* the best performance value in terms of age of vehicle fleet is in Luxemburg, while the lowest one - in Greece. This type of indicator is also included into the technical-operational dimension of the *JRC SusTrans Index* showing the same result. In terms vehicle fleet age the situation is critical in Spain and Italy and in the New EU Member States. Future transport sustainability policies of the EU strongly emphasize the importance of the technical state of the vehicles as newer vehicles emit lower amount of emissions. In general, stricter standards controlling the age of vehicle fleet is an important issue of transport sustainability policy strategies in the EU.



**Figure 72 Map of the EU Member Countries Ranking on the basis of Indicator of Average Age of Vehicle Fleet (green color denotes high sustainability performance, yellow- medium and red - low performance).**

### 5.6 Benchmarking Transport Sustainability Performance in the EU27

In the sections above we have discussed the outcomes of all the sustainability dimensions of the *EEA TERM Index* and used it as a reference point for comparison with results obtained from the *JRC SusTrans Index*. In this way the *EEA TERM Index* served as a valuable benchmark to assess and to compare transport sustainability performance in the EU. Figure 73 reveals the correlation of the EU countries ranking by both indices. It shows similar performance of the countries ranking at high and low sustainability performance scores.



**Figure 73 Correlation between the EEA TERM Index and the JRC SusTrans Index showing the EU Member States Ranking Performance.**

Bulgaria (also Luxemburg, Malta, Germany, Greece, Estonia and Hungary ) is clearly an outlier in the correlation graph. This may suggest quantitative data inconsistencies between the two indices in terms of sustainability performance for this country (Figure 70), but it also incites to compare differences in the structure of the two indices. Usually, adding or omitting indicators can easily be justified within any given framework, but one should be aware that this can change the message.

## 6 CONCLUDING REMARKS

The current study focusing on the measurement and assessment of transport activities by using two selected sets of indicators revealed a complex picture of EU27 transport sustainability performance, which is reflected in the ranking of the EU Member States, and more explicitly in the pie charts showing individual strengths and weaknesses. In the paragraphs below we give a short summary of the major observations and findings.

One of the principal aims of this study was to collect quantitative data matching the proposed set of selected transport sustainability indicators. Due to limited availability of data out of 55 proposed indicators 32 matching quantitative indicators have been collected and aggregated into the *SusTrans Index* using the equal weight aggregation method. Many obstacles have been found in collecting quantitative data as for many EU countries quantitative data is lacking. Certain data are hard to express in quantitative terms (e.g. some environmental assets, cost of externalities, internalization etc.). Even data estimation methodologies for certain aspects could not be applied thus leaving our data set with a smaller amount of indicators than originally expected.

Due to the lack of data for the institutional sustainability dimension, out of five originally proposed sustainability dimensions to which we have referred in the text as “the Daisy Concept” only four sustainability dimensions (which are environmental, social, economic and technical/operational dimensions) have been analyzed in quantitative terms. It was difficult to obtain complete and reliable quantitative data for the institutional transport sustainability dimension which focused on such composite parts as expenditure for research and development for transport, total expenditure on pollution prevention, measures taken to improve public transport and strategic environmental assessment for the transport sector. These data gaps may suggest that institutional part in terms of quantitative data should be strengthened by data collecting agencies. The institutional part is equally important as other sustainability dimensions and contributes to the complete picture of transport sustainability performance.

Measurement and evaluation of transport sustainability activities in the EU27 has been performed using equal weight aggregation method which is a commonly used approach in many international indices and indicator sets. “The Dashboard of Sustainability” graphic interface has proved to be a useful modeling tool in the assessment and visualization of transport sustainability performance using quantitative data.

On the basis of these indicator aggregation and modeling techniques we have obtained the *JRC SusTrans Index*. The *EEA TERM* transport indicators have been also aggregated and assessed in the same methodological manner and resulted in the summarized the *EEA TERM Index*. The *EEA TERM* index has been used as a reference point to benchmark the results of transport sustainability performance of the EU Member States obtained by the *SusTrans Index*. The structural differences between the two indices lie in the composition of indicators: the *TERM Index* focuses on environmental, economic and technical aspects, while the *JRC SusTrans Index* additionally includes social and institutional dimensions. In spite of small structural differences and slightly different number of quantitative indicators analysed in this study, the two indices look at the same issue of transport sustainability performance and, thus, have been considered as similar and comparable.

The results obtained by both indices reveal many similarities. Interestingly, ranking obtained by both the *JRC SusTrans* and the *EEA TERM* indices suggest that Germany, Belgium, Netherlands are among the best performing EU Member States in terms of transport sustainability. According to both indices the lowest transport sustainability performance is observed in the Eastern EU Member States, among which are Greece as well as Estonia, Bulgaria and Lithuania. Both indices agree that in terms of energy consumption in transport sector the Older EU Member States (EU-15) perform better. However, emissions from transport activities are lower in the New EU Member States (EU-12)

compared to the other states. Economic transport sustainability performance shows similar results in both indices suggesting better performance in Western EU countries and lower performance in New EU States. Technical dimension of two indices also shows similar result: the highest ranking performance of technical/operational dimension is observed in Luxemburg according to the *TERM Index* and in Belgium according to the *SusTrans Index*. The lowest performance score in terms of technical dimension is obtained by Greece according to the *TERM Index* and according to the *SusTrans Index* -in Bulgaria (which is a neighbour country of Greece).

The trends of transport sustainability performance analysed on the basis of the *SusTrans Index* for the period from 2000 to 2005 reveal that the situation in terms of economic and environmental sustainability performance has deteriorated in the majority of the EU Member States. Therefore, the future EU transport sustainability policies aiming to achieve greener transport systems should strengthen environmental and economic dimensions.

The differences between the two indices in ranking are mainly due to the differences in their structural composition. For example, the *TERM Index* does not include social transport sustainability dimension, while social indicators are incorporated in the environmental and technical dimensions of this Index. The *TERM Index* has three major dimensions namely environmental, economic and technological, while the *SusTrans Index* in addition to these three sustainability dimensions has also social and institutional one (although institutional is not analysed in quantitative terms due to the lack of data as discussed previously).

The correlation analysis between the two sets of indices indicates that countries ranking high and low in terms of transport sustainability correlate well. This in turns suggests that performance evaluation results are similar. Bulgaria is marked as an outlier on the correlation graph; this may suggest quantitative data inconsistencies between the two indices in terms of sustainability performance for this country.

This study raises several questions that are important in terms of transport sustainability. It can be concluded that several transport sustainability issues in terms of missing data should be strengthen. Apart from transport indicators within the institutional dimension, quantitative data collection for renewable use in transport, costs of externalities and internalisation costs information could be improved. Also more attention should be devoted to the development of more comprehensive databases which regard public transport issues. Enhanced collection of data for these issues would strengthen development of more efficient transport sustainability policies and strategies.

The issue of mobility, which in our study is reflected by the indicator *share of transport in household expenditure* deserves further attention and discussion. The issue itself in our study is defined to be contradictory: the question is how to increase the use of public transport which is more sustainable and how to estimate the real cost of transport use rather than the price of transport. If we have in mind public transport, lower costs mean that the whole family has access to a good public transport. If instead this indicator focuses on private transport, lower cost of transport would mean unsustainable transport trends, i.e. more car use, more pollution and consequently more CO<sub>2</sub> emissions etc.

In summary the application of the Dashboard of Sustainability tool in our study has helped to efficiently visualise the situation of transport activities in the EU27 on the basis of the *SusTrans* and the *TERM Indices*, and to discover many surprises that would have been overlooked had we only looked at spreadsheets filled with data. The analysis has been useful in identifying the strengths and weaknesses of transport performance in the EU and highlighting the major issues which should be in the priority action agenda of the policy makers in terms of constructing sustainable transport scenarios and strategies. Clearly, the report has outlined also the weaknesses of this study, in particular the lack of data for a *comprehensive* assessment of transport impacts. Future work should focus on expansion and development of the *SusTrans* indicator set and on further quantitative data collection and improvement of data quality. Also, the methodological approaches used in this study could be cross-



checked using other indicator aggregation methods (e.g. the Edges method, the Data Envelopment Analysis (DEA), etc.).

On the basis of the obtained information it can be suggested that higher attention should be given to environmental and economic transport sustainability dimension as these have shown performance deterioration over the period from 2000 to 2005. This comes back to the issue of decoupling of transport growth from the economic growth. Orientation of transport activities in the EU towards more sustainable ways could be achieved by implementing renewable energy resources, promoting public transport, enhancing higher occupancy rates of private and public transport, lowering transport emissions and energy consumption. Along transport policy lines currently, several medium and long term strategies applied to transport activities are being proposed by the EU Institutions. Recently the European Commission has issued “The Greening transport package”, which seeks to steer the European transport sector towards enhanced sustainability. The specific aims are to ensure that the prices of transport better reflect their real cost to society in terms of environmental damage and congestion, to introduce more efficient and greener road tools for lorries and to reduce noise pollution from rail freight (EC, 2008). Thus, every action of the EU Institutions and the EU Member States Governments addressing the issues of transport sustainability could contribute to greener and more sustainable transportation system in the EU. Our report provides some useful ideas pointing to the strengths and weaknesses of transport activities in the European Union.

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## **Abstract**

Inspired by the growing interest of academic and policy environments in the field of transport sustainability, this work focuses on the measurement and assessment of transport activities in the European Union (EU) with the use of transport sustainability indicators. On the basis of major international transport related indicator initiatives a set of 55 transport sustainability indicators has been developed (as defined in the first part of the report by Dobranskyte-Niskota *et al.*, 2007) where due to lack of data 32 indicators have been assessed in quantitative terms and *the JRC SusTrans Index* has been developed. The Joint Research Centre software tool entitled “the Dashboard of Sustainability” based on a simple graphic interface has been applied to *the JRC SusTrans Index* in the assessment of transport sustainability performance in the EU Member States. The Dashboard tool has compared indicator groups using the EWA method and communicated a quick impression by pointing to areas where transport indicators showed particular success or problems. Additionally, the Dashboard tool has been also applied to the Transport and Environment Reporting Mechanism (TERM) indicator set developed by the European Environmental Agency and *the TERM Index* has been calculated. The TERM Index has been used as a reference point to benchmark transport sustainability performance results of the EU Member States obtained by *the SusTrans Index*. The outcomes of the two indices (*the SusTrans* and *the TERM*) have revealed the highest rank of transport sustainability performance in Germany and Netherlands while the lowest performance ranks - in Greece and Bulgaria. The results of the two indices have revealed many similarities, while some differences in the outcomes observed are due to the variations in the structures of the indices. This in-depth analysis of EU 27 transport activities by the selected sustainability indicators using adequate modelling tools serves as valuable guidelines for forming transport policy strategies and scenarios. These policies aim to reduce negative impacts of transport activities with the final goal of achieving a sustainable transportation system in the European Union.

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